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Transformer Testing. ALTHOUGH much has been published on transformer testing and on the results of such tests, yet good comparative values to which no valid objections can be raised are rare; and, therefore, those interested in this subject will find the elaborate and carefully made tests of Dr. Fleming, which we publish in abstract, to be well worth their attention. Among other things, he points out what great errors may be made in measuring alternating currents with certain instruments under certain conditions. In one particular case, for instance, he shows that an error of one per cent. in the reading of an instrument may cause an error of 40 per cent. in the result. The difficulties encountered in making alternating current tests are fully appreciated only by those who look into the matter carefully. It may be a very easy matter to simply put an alternating current volt or ammeter in circuit and take the readings, but it is quite another matter to make sure that these readings express the true conditions.

Secondary Batteries for Central Stations. IT has been a source of astonishment to foreign engineers that the use of secondary batteries in central station work has been entirely neglected in the United States. In Europe they are now recognized as an important factor in continuous current distribution, whether employed as regulators, relays in central stations or as sub-station sources of current. We are glad to announce that during the coming week one of the Edison stations in this city will connect a secondary battery plant to its mains. The batteries are of the Crompton-Howell type, composed of Planté elements of a highly porous lead, and in introducing this type in preference to pasted plates the best practice of European central stations has been followed. There are 51 plates to a cell, each about eight inches square, and it is understood that 180 cells are to be employed, which, presumably, will give a capacity of over 1,500 ampère hours. The experience with this pioneer plant will be watched with great interest, and may lead to considerable remodelling in our continuous current central station practice.

Another Novel Form of Electrical Advertising. THE "celestial advertising" scheme which the Englishmen are now developing with great eclat, and which we commented on a few weeks ago, has called forth from the humorist of our contemporary *Industries* another novel scheme, which is as amusing as it is sarcastic. After stating that there still seems to be a little difficulty in carrying out the scheme, he goes on to explain: "The ordinary alternator makes a continuous hum, because the curve of one-half period is the same as that of another. By building special alternators any curves could be produced. Any speech can be represented by a curve as drawn, for instance, by the old phonautograph. The dynamo is therefore built to give the curve corresponding with the advertisement. For instance, suppose the advertisement ordered is 'Someone's Soap,' the dynamo is designed not to hum in the ordinary monotonous way, but to sing 'Someone's Soap! Someone's Soap!' one repetition per revolution. The transformers in the houses are also arranged to hum a little, and sounders are applied throughout the system of distribution. There is added to the noise of a busy city the persistent but unobstrusive substratum of 'Someone's Soap! Someone's Soap!'"

Electric Cars on the Brooklyn Bridge. THE statement is made by the president of the New York & Brooklyn Bridge Company that within two years electricity will be the motive power for the bridge cars. Such a movement will not only be welcomed by electrical engineers and those directly interested in the application of electricity to traction work, but by the public at large and especially the great mass of people who are obliged to cross the bridge daily to reach their places of business. While the present cable cars are very satisfactory in most respects there is no doubt that an electric system would be an improvement. It frequently happens, especially during wet weather, that an accident to the cable interrupts traffic at a time when it is the heaviest, and these troubles could certainly be avoided with proper care on an electric line. The thumping of the cable as it is picked up by the cars is far from agreeable, and the continual noise all along the line is rather annoying to pedestrians. The great flexibility of an electric system would especially commend its use here and the cost would undoubtedly be in its favor. In addition to the power required to drive the cable under the present method of operation, four of five steam locomotives are employed to shift the cars, while with electricity this additional expense would not have to be borne, not to mention the freedom from the noise and dirt. It is to be hoped that the advantages of electricity as a motive power will lead the managers of the bridge to take some active steps in this direction in the near future.

Life of Incandescent Lamps. NOW, after consumers and makers of incandescent lamps have been accustomed to regard long lived incandescent lamps as great achievements in lamp making, Mr. O'Keenan comes out with the statement, which will doubtless seem startling to many, that it will be more economical to break lamps by force if they last longer than a few hundred hours. In other words, he shows that at a certain age in its life a lamp arrives at what he appropriately calls the "smashing point," that is, a point at which it will be more economical to break the lamp than to continue to use it. Strange as this may seem, the method by which these results are arrived at and which is explained in detail in another column, appears to be quite rational. He simply divides, for each hour of its life, the total cost of the light, including lamp and power, by the amount of light obtained up to that hour, and finds that for the first few hundred hours, varying from 200 for some lamps to 500 for others, the cost of the light continues to diminish but after that it increases; so that it pays best to throw the lamp away at that age and use new ones. Or, to use a slight modification of an old adage, he finds that "there is a tide in the cost of light which taken at the ebb leads on to fortune." It will be hard to convince some people that it is to their interest to throw away apparently good lamps at such an early age, especially when they claim that by doing so they must send out to the store and buy new ones to replace these. But if they can and will look into the matter they will doubtless find the results to be correct or nearly so; at least, such is found to be the case with all the most important European lamps and it is not unreasonable to suppose, until we know to the contrary, that American lamps follow the same or nearly the same law. The explanation in popular language is simply that the age of enfeeblement sets in much earlier in the life of a lamp than is generally supposed. Or, in other words, the vigorous youth of a new lamp compensates for its first cost, and it is therefore uneconomical and expensive to keep an old enfeebled lamp in service; just as in the case of some useful animals, incandescent lamps arrive at an age of uselessness before their natural life is ended. It is not to be recommended, however, that consumers should at once start in to break all lamps older than a few hundred hours, but we do urge them not to run lamps so long that a great portion of the light never gets through the blackened bulb, and also that it might be very much to their interest to force their lamps, as it may cost less in the end.

Where the Block System Fails. THE tremendous volume of passenger traffic on our thousands of miles of steam railroads every day in the year makes the subject of proper protection of running trains from danger of collision with other trains on the same track a matter of the greatest importance. As is well known the best protection yet afforded in this respect is that furnished by the block signal system, in which the road is sub-divided into sections of such a length that it is possible to give up an entire section to a single train so long as that train is passing through it. It is also well known by those who have given any attention to the subject that the very best block system becomes absolutely worthless if the signals which are automatically displayed are not implicitly obeyed by engine drivers. Experience has shown that a very large percentage of engineers are ready to take large risks even when the signals indicate that there is danger in running past them. A case in point is the rear end collision on the Central Railroad of New Jersey at Greenville, N. J., a few days ago. In this case two trains were dispatched from the station in Jersey City one minute apart. Both trains were running at a high rate of speed and both were behind time owing to a somewhat dense fog prevailing at the time. The train in the lead, owing to the supposed accident, came to a standstill just beyond the signal post which marked the entrance to one of the 2,000 feet blocks into which the entire road is divided, and which are protected by the Westinghouse electro-pneumatic signals. The distance or caution signal was 2,000 feet back, that is, upon the same post with the home signal at the entrance to the preceding block. The following train came along at a high rate of speed and could not stop until a rear end collision with the preceding train had taken place. In this case the caution signal told the engineer of the following train that the train ahead of him was in the next block, and he understood well enough that his speed ought to be decreased, so that he would be able to stop before entering the block, 2,000 feet ahead of the caution signal. As it was, he disregarded the caution, and being behind time, took the risk, expecting to find the block clear, and continued at the ordinary speed, even though the dense fog prevented his seeing the train ahead until he was almost upon it. The point of all this is that the block system as at present operated gives ample protection only when the signals which it displays are strictly obeyed. Just here an important advantage would be gained by the substitution of electric power for steam in the operation of trains at high rates of speed, for in this case the automatic signal system could compel the engine driver to obey the signal by cutting off the current from his train as soon as he had passed the distant cautionary signal. Under these conditions, provided the blocks were of sufficient length, it would be impossible for a rear end collision to occur, as a system of automatic switches might be arranged so that a dead section of the line would intervene between any two moving trains. An effort has been made to secure the same results in steam railroad operation by equipping the locomotive with an apparatus by which upon passing a cautionary danger signal the throttle is automatically closed by the action of a solenoid through which the circuit is closed as the signal is passed. In this case, however, each locomotive must be equipped with the apparatus, while in the case mentioned above the equipment would be entirely outside of the engineer's control and would be a part of the line equipment rather than an accessory to the electric locomotive.

Advantages of Forcing Lamps at the Expense of Their Life.

BY CARL HERING.

It has long been well known that the efficiency of an incandescent lamp increases very appreciably the more it is forced, that is, the number of watts required per candle power of light becomes less the greater the current which passes through the lamp, or, in other words, the greater the voltage to which it is subjected. It is also well known that, on the other hand, the life diminishes very rapidly the more a lamp is thus forced. As the total cost of the light increases by going to either of the two extremes of long life and poor efficiency on the one hand, and good efficiency with short life on the other, there must be some intermediate value for the life and the efficiency which would give the most economical results, considering both the cost of the lamp and the power required. Numerous different methods have from time to time been suggested and used to determine this point with more or less success. But they have all apparently led one to believe that a long life is a most desirable feature, so much so that extremely long-lived lamps were considered as great achievements in lamp making. More recently the tendency has been to increase the efficiency slightly and to diminish the life, but this may have been due to the lowering of the price of lamps, which would naturally lead to using higher efficiencies. But it appears now from the somewhat surprising results of the very interesting deductions of Mr. O'Keenan described recently by Mr. Hospitalier, that the most economical point, considering all the factors involved, is very materially different from what was generally supposed, and that it is in fact cheaper to replace old lamps with new ones after only a few hundred hours, rather than to continue to burn the old ones. He shows that there is a point in the life of each make of lamps at which it will pay best to break the lamps, and he gives this point the appropriate name of the "smashing point."

The ingenious way in which he arrives at these results, though somewhat laborious, appears to be the most rational method of any of those suggested, as it is based on life and efficiency tests and takes into account every factor, including blackening of the bulb and falling off of the efficiency with age. He simply deduces a curve which shows for each hour during the life of the lamp what the average cost of the candle power hour of light from that lamp has been up to that time. These curves show that this cost is lowest at a certain age of the lamp, after which it again increases, and that it is therefore cheaper to throw the lamp away after that age.

These curves are deduced as follows: To start with one must obtain from a life and efficiency test the curve, which we will call *a*, giving the amount of energy in watts which is being consumed by the lamp at each hour of its life; and, also, the curve, which we will call *b*, giving the candle power of the lamp at each hour of its life. A set of *b* curves for a number of different European lamps is shown in Fig 1.*

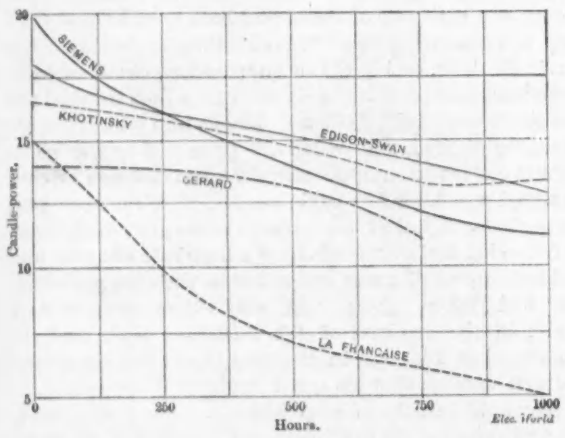


FIG. 1.—CANDLE POWER AS A FUNCTION OF TIME.

From the consumption curve *a* deduce a new curve which gives for each hour in the life of a lamp the *total amount of energy in watt-hours which the lamp has received since it was started.* This new curve, which we will call *i*, which is the integral of the curve *a*, will approximate a sort of diagonal line passing through the origin. Multiply these ordinates by the cost of a watt-hour of energy in cents, or what amounts to the same thing, change the scale of ordinates so that they read in cost of a watt hour in cents. Now add to these ordinates the original cost of the lamp in cents (which is equivalent to lowering the axis of the abscissæ by an amount equal to the cost of the lamp), or simply add this to the scale of the ordinates. The resulting curve, which we will call *c*, will then give for each hour in the life of the lamp the *total* cost of the lamp and the power up to that hour.

The calculation for determining the ordinates of this integral curve *I* is the most tedious part of the work. The ordinate for each hour of the new curve *I* ought to be equal to the sum of all the ordinates on curve *A* for *every hour* from the start to that particular hour. Or, in other words, for each hour the ordinate of the curve *I* is equal to the one for the preceding hour plus the ordinate of curve *A* for that hour. This involves a calculation for every hour of the life. A much shorter approximate method, however, is to take the mean ordinate on curve *A* for, say, every 10 hours, multiplying it by 10 and adding this quantity to the ordinate of curve *I* for the preceding 10 hours. The units for the scale for the *I* curves must of course be very much smaller than those for the *A* curves. Those familiar with the use of the planimeter may use it to advantage for taking areas on the curve *A* and using these as ordinates for the new curve *I*.

From the candle power curve *B*, corresponding to those in Fig. 1, giving the candle power for increasing ages, deduce as described above a new curve which gives for each hour in the life of the lamp the *total amount of light in candle power hours which the lamp has given out since it was started.* This curve, which is the integral of *B*, will also approximate a sort of diagonal line passing through the origin; let this curve be called *D*.

It is evident that if for any age of the lamp the total cost of the lamp and the power *since it was started*, as given by the curve *C*, be divided by the total quantity of light in candle power hours obtained *since it was started*, as given by the curve *D*, the result will be the average cost of a candle power of light up to that age of the lamp; this is the quantity which we wish to find. If, therefore, the ordinates of the curve *C* be divided by those of the curve *D*, the quotients when laid off will give the desired curve. Such a set of curves for a unit of 10 candle power is shown in Fig. 2,* in which the cost of the lamp was

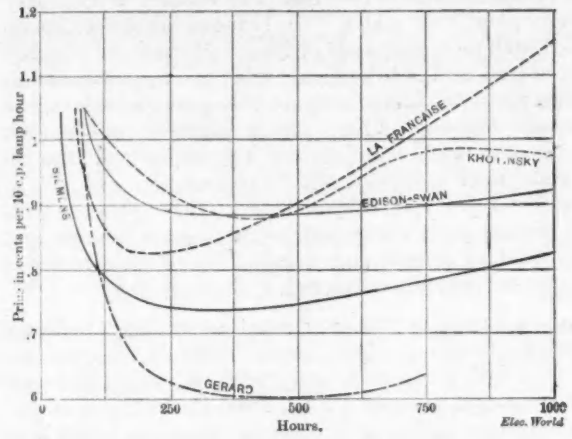


FIG. 2.—SPECIFIC COST AS A FUNCTION OF TIME.

taken as 40 cents and the energy at 20 cents per kilowatt hour. These curves are for the five different European lamps of which the candle power curves are shown in Fig. 1, which were taken from the tests of Mr. Ch. Haubtmann published in *L'Electricien* of Sept. 24, 1892, page 201. Referring to Fig. 2 it will be seen that the ordinates of each curve have a minimum value; this is the point at which the average cost per candle power hour is least; if the lamp is kept burning beyond that age it will be seen that its average cost again increases. This is the point which Mr. O'Keenan terms the "smashing point," for at that age it will be more economical to break the lamp than to continue using it. Perhaps the more dignified expression of "age of decline," or "most economical age" might be more acceptable to some.

Strange as it may seem to many, this point is reached for some lamps at the early age of 200 hours, and for none of them later than 500 hours. It is not unlikely that the American lamps would give about the same results. The curves will be given by the writer in a subsequent article if the desired information can be obtained.

Although the idea that a lamp should be worse than useless at such an early age may at first seem hard to believe, yet the method by which these results are obtained seems to be quite correct, as it is in fact nothing more than dividing the total cost of the light by the total amount of light received, a very simple, business-like way of calculating costs, and it is therefore a matter well worth the attention of lamp makers and consumers.

The minimum points in these curves owe their existence to the fact that the candle power and the efficiency diminish as the age increases; if both of these remained constant throughout the life, the curves in Fig. 2 would have no minimum point but would approach to the base line, in which case the longer the life the better. This constancy is the incorrect assumption formerly made in such determinations and it naturally shows long life to be a very desirable feature. The present method, taking into account the blackening of the bulb and the loss of efficiency, is therefore undoubtedly more correct than the older method, in which this was left out of consideration. To keep an old blackened lamp in use is well known to be a foolish luxury if the consumer has to pay for the power, but it was not known before just at what point it is cheapest to stop it.

The conclusions to be drawn from these curves are naturally that as the life of the lamp is of no consequence after a few hundred hours, it will therefore be far better to force them, thereby obtaining a greater efficiency and cheaper light. Forcing them will on the other hand blacken them at an earlier age, but as the efficiency is so much higher to start with, it will doubtless be a gain in the end, provided such forcing is not carried too far.

As this method of finding the most economical age is deduced from the actual candle power received and the total cost, including the lamp, it applies only to cases in which these factors are to be considered, as, for instance, in all private installations. A central station manager, for example, who does not seem to be concerned with the actual candle power of the light, provided only that the lamps are labeled "16 c. p.," will of course run them until they die a natural death. The same with parties whose power costs nothing but whose lamps do; also in places where the diminution of candle power with age is of no great importance.

The most economical age as shown by the curve will also depend upon the relative costs of the lamp and the power. As the power becomes more expensive, the minimum point of the curve will move to the left; that is, it will be more economical to force the lamps still more, while, if the price of lamps becomes greater, the point will move to the right showing that it will be more economical to run them longer.

In conclusion, it is no more than fair to others to say that the idea of taking into account the diminution of the candle power and efficiency for determining the point at which the life is practically ended was suggested some time ago, at least as far back as the June meeting of the American Association of Electrical Engineers, if not earlier; but the ingenious and rational method devised by Mr. O'Keenan for determining the exact point appears to be new.

* Taken from *L'Industrie Electrique.*

*Taken from *La Lumière Electrique.*

Electric Heating as Compared with Heating by Coal Direct.

In a paper read by Mr. P. K. Stern at a recent meeting of the Buffalo Electrical Society, on "The Elementary Principles of Electrical Heating, with a Comparison of Its Commercial Value to That of Coal," he makes some deductions which may be of interest, showing the comparative costs of electrical heating and ordinary heating by means of coal.

From calculations made of the amount of heat given out in a coal heater and in an electric heater he concludes that the former is seven times the latter, or, in other words, it will take seven times as much coal to produce the same amount electrically as by means of the ordinary coal heater. But allowing for the difference in price between the hard coal used in stoves and the soft coal in an electrical station, the cost is reduced to about two and one-third times the price of stove or furnace heating. He points out the fact that in coal heating there is necessarily a great waste, while in electrical heating much greater economy can be exercised. This still further reduces the cost of electrical heating. He mentions an electrical water heater which is attached to an ordinary faucet in such a way that the cold water on passing through it instantly becomes heated to a temperature which may be regulated as desired. This avoids the use of large quantities of hot water being kept on hand, which naturally represents a waste of heat.

At the price charged by electric lighting companies, which he gives at $70 per horse power per year, or 14 12 cents per horse power per hour, it would cost about 114 times as much to heat by electricity as by coal at $6.50 per ton. At $2.85 per meter horse power per hour, or about $24.96 per horse power per year he says that the rate would be about the same as coal at $3.00 per ton. At the present price of hard coal, $6.75, together with the labor of delivery, attendance, kindling, and the ash nuisance as well as fire risks, it appears that the cost would compare favorably with that of electrical heating. He ends up by saying "with the Niagara River at our back let us hope for the joy and comfort this luxurious system may afford us in our homes in the near future."

The Chicago & St. Louis Electric Railroad.

A bill has been laid before Congress which has for its object the encouragement of the construction of electric railroads. It was introduced in the Senate by Mr. Vest and in the House by Representative Forman, and provides that the Chicago & St. Louis Electric Railroad Company, and any other electric railroad companies hereafter organized under the laws of the United States, or any State or Territory thereof, which may construct and put in operation an electric railroad 100 miles or more in length within two years, shall be authorized to import free of duty, to be used in the construction and operation of the road, electrical machinery, iron or steel rails, engines, locomotives, cars, and other appliances adapted to the use of electric roads.

Upon the application of the Chicago & St. Louis Electric road the Postmaster-General is authorized to contract with the company for carrying the mails at existing rates for ten years between Chicago and St. Louis, upon condition that they shall be transported at not less than 100 miles per hour. The company is to obligate itself to furnish to farmers and others along the line of the road, whenever requested to do so, electrical power for agricultural purposes, and electricity for light and motive power at reasonable rates.

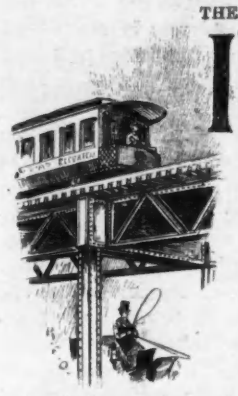
The road shall at all times transport troops and munitions of war, supplies, and public stores whenever required to do so by the government, which shall have preference in the use for the purposes aforesaid.

The bill was referred to the Committee on Commerce.

Electricity at the World's Fair.

(From Our Special Correspondent.)

THE SUPPLY OF FUEL.



IT is probable that no one item bears more importance to any steam plant than that of fuel. In many localities there is practically no choice in the matter, but in discussing the general features of a plant of the magnitude and purpose of that at the Columbian Exposition, the question of what fuel to use and how to handle it was one of the greatest importance.

From the first in this discussion, however, the advantages of oil for fuel under the particular conditions were manifest. The small volume and consequent small space required for handling, the ease with which it could be delivered, the freedom from all care of ashes and from dust, smoke and soot, considerations naturally of the greatest importance, all made strong arguments in its favor.

Bids, however, were publicly taken for fuels of all kinds, the only requirements being that each bidder stipulate the guaranteed number of heat units per pound of his fuel.

After some necessary discussion and some slight investigation of the feasibility of installing an elaborate and costly system of coal and ash handling machinery of one sort or another, the bid of the Standard Oil Company was finally accepted and a contract entered into with it by which the Exposition Company is to pay 72½ cents per barrel for every barrel of 42 gallons delivered, the Standard Oil Company to furnish all oil that may be required for fuel. And, also according to the terms of the contract, the Exposition Company were to provide suitable storage tanks for the reception of the oil and all means of handling same after its delivery to the grounds.

For insurance reasons it was desirable and necessary to put the oil plant as far as possible from the neighborhood of any of the large and important buildings, and hence the site was selected in the extreme southeastern corner of the grounds.

In the design of the oil plant great care was taken to follow as closely as possible the rules of the Chicago Fire Underwriters' Association, but on account of the magnitude of the plant and its particular location, it was necessary to make some slight changes in a few minor details.

The storage tanks are twelve in number, eight feet in diameter (not six as formerly published), and 25 feet long.

The capacity of each tank is 9,400 gallons, giving an aggregate of of about 112,500 gallons.

The twelve tanks are placed underground in a brick vault, 72 feet long by 69 feet wide, which is divided by 18-inch brick partitions into sixteen distinct compartments, making practically a separate vault for each two tanks. The brickwork of the vaults is laid up with Portland cement mortar, well grouted. The floor consists of 18 inches of Portland cement concrete, and the roof of iron beams with brick arches. On account of the water in the soil, the vault being very near the lake, it was impossible to go more than five feet deep, but the earth is graded up and covers the vaults with 12 inches thickness. With this arrangement of the tanks and vaults, should any fire or explosion occur, it will be confined to the two tanks in one vault, and it will be impossible for the oil to escape, notwithstanding its rapid expansion under heat, as the volume of each vault is more than twice that of the tanks which it contains.

The oil will be delivered to these tanks from the oil fields of Ohio and Indiana by a continuation of the line which supplies factories at South Chicago. The oil is delivered to the boilers by means of a small pumping plant located int the oil-pump house 45 feet east of the vaults. This plan contains two 10 × 6 × 10 · Snow duplex pumps for the oil, two 42-inch independent vertical boilers with feed pump injector and heater, besides the standpipe 80 inches diameter and 300 feet high for maintaining a uniform pressure on the oil main.

FIG. 1.—TRANSPORTATION BY ELECTRIC LAUNCHES.

The pumping plant for the oil is arranged entirely in duplicate, so as to render the danger of stops as slight as possible. In regular operation the pumps take their suction from the tanks in the vaults, and deliver into the standpipe. A single five-inch wrought iron pipe, 3,200 feet long, laid in an almost geometrically straight line, connects the standpipe with the centre of the boiler house. At this point the pipe branches, running the entire length of the boiler room, with connections for the burners under each boiler.

Arrangement is also made by which, should anything happen to prevent the delivery of oil to the storage tanks by the pipe lines, it may be delivered in cars. For this purpose a switch track is located convenient to the vault, and a connection is made by which either oil pump can take suction from the tank cars and deliver into the storage tanks. There is also a suction connection to each pump from the pipe line between the standpipe and the boiler house, so that, in case any accident occurs at the connections at the boilers, or on the main line, by the opening of two valves, the delivery can be stopped and the pump used to draw off all oil from the line.

The arrangement described gives to each pump three suction connections—from the storage tanks, from the car line and from the delivery line; and two delivering connections—one to the standpipe and one to the storage tanks and the piping is so designed that either pump may be used on any service independently. There is also an overflow from the standpipe arranged with a quick opening relief valve connection, such that should a fire occur in the standpipe it can be at once emptied into storage tanks. A by-pass is put in the pump delivery so that the standpipe may be at any time taken out of service if it is desirable, for cleaning or other purposes. There is, moreover, a system of heating pipes arranged in the tanks and along the main line, as there is some danger in cold weather of the oil becoming very viscous and sluggish.

The vaults for the storage tanks were erected by the Exposition Company, and a contract was entered into with the National Supply Company, of Chicago, for the tanks, standpipe, pumps, boilers, and all piping required, including the connections to the burners in the boiler house. At this date the work at the vaults and pumping plant is practically completed, and the connections at the boilers are being rapidly made.

The fuel oil plant as installed at the Exposition will give ample and public test of the advantages of natural oil. But in a plant where cleanliness in almost above all other things most desirable, its advantage would seem to be paramount and one of the boiler makers represented has talked facetiously of carpeting his portion of the boiler room with Brussels carpets and uniforming his firemen in white duck. As to the fuel at other points on the grounds but little will be required. There are now in operation a boiler plant for heating the Horticulture and Service buildings, and a small one for heating the aquarial department of the Fisheries, besides the temporary power plant, which is still doing service. During the Exposition the Libby Glass Company will run a small plant for its exhibit in Midway Plaisance, and there will be a separate one for the elevated railroad. But all boiler plants, except the main one, which are operated during the Fair will be obliged to burn anthracite coal, as very stringent smoke regulations will be enforced, and all handling of coal or ashes will be done at night. It is the intention of the authorities to have all parts of the grounds as cleanly as possible.

Opening Ceremonies.—It seems to be settled that the final dedicatory exercises on May 1 will be of very much less importance than were those held Oct 20 and 21 last. As an advertisement the exercises referred to were a great success whatever may have been their artistic or historic merit. People visited Chicago from every State in the Union and from every civilized country on the globe, and on returning home they sang the praises of Chicago and her World's Fair buildings. It has just dawned on the Board of Control that it is not possible to get further benefit from a great display costing a great sum of money, and it is probable that President Cleveland will be asked to declare, in a few words, that the greatest exposition the world has ever seen is ready for the public and, pressing a button, set the machinery in motion. This will be democratic and will meet the approval of the American people. The Committee of Ceremonies, of which Colonel Culp is chairman, has spent some time dur-

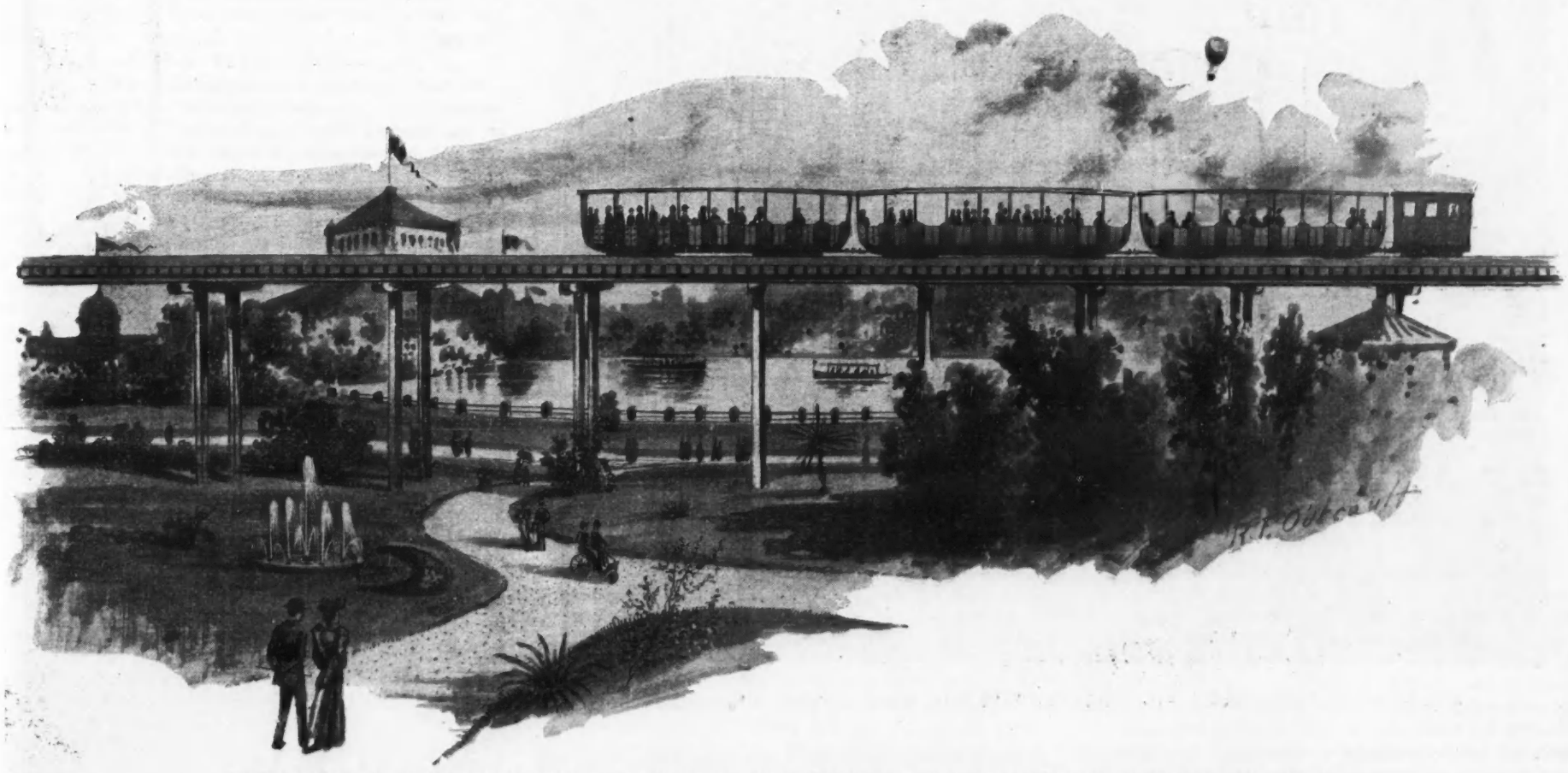


FIG. 2.—TRANSPORTATION ACROSS THE WORLD'S FAIR GROUNDS BY THE ELEVATED ELECTRIC RAILROAD.

ing the past month in arranging a programme for the May Day exercises, but on Thursday last the Board of Control put a stop to all proceedings by refusing to make an appropriation for the purpose. The committee had nearly completed an elaborate programme and the members were congratulating themselves on the progress made when they were notified, not only that there would be no great dedicatory ceremonies, but that there was no further business for the committee, wiping out at one stroke the committee and its numerous clerks and officers. A sub-committee on ceremonies has been appointed, three from the directory and three from the commission, having full authority to

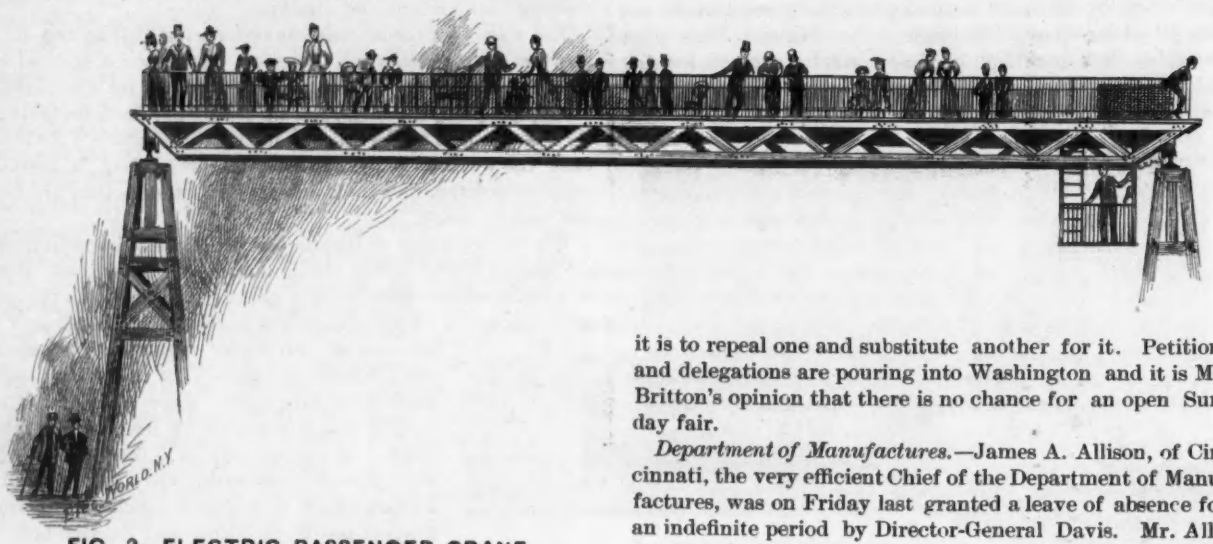


FIG. 3.—ELECTRIC PASSENGER CRANE.

designate the days set apart as State days, and to arrange such other matters as may be necessary after May 1.

The United States Government Building is now ready for installing exhibits, and in consequence will be closed to visitors until the opening next May.

Contracts.—At the meeting of the Board of Control on Wednesday last it was reported that the Art Institute has spent over $250,000 to date, in the construction of its building on the lake front, and it was decided to make the $200,000, which the directory has contributed to the work available, to be paid from time to time as the work progresses. The contract for the construction of the choral building, awarded to James McGonigle for $86,533.50, was approved. The contract for docking to carry a railroad track, and for the abutments to the viaduct at Van Buren-street, together with 30 feet of platform, was awarded to the Green Dredging Company for $16,200. This contract includes the laying of rails.

Sunday Opening.—General St. Clair has recently returned from Washington, but is non-committal as to the prospects for the repeal of the Sunday closing law. Opinion in Chicago is crystallizing into the belief that Congressman Durborrow will fail to get the votes necessary to carry this measure. It is generally believed that the next Congress will be more friendly, and every man that one meets, a Democrat or a Republican, is strongly in favor of a special session in March. It is feared that if the bill comes to a vote during the present session that conditions will be imposed that will not be accepted by the World's Fair officials. It is hinted that there are men at Washington who want to control more of the patronage of the fair, and that unless they are allowed to make a large proportion of the Exposition appointments next year, they will fight Sunday opening to a finish. A tremendous public sentiment in favor of the repeal of the Sunday restriction clause passed by Congress has been created throughout the country and the greal balance of public opinion is undoubtedly in favor of Sunday opening, but trouble is expected from the Washington politicians and the World's Fair people are correspondingly blue. Commissioner A. T. Britton, of the District of Columbia, is also in the city. He says that it is much easier to pass an original bill through Congress than it is to repeal one and substitute another for it. Petitions and delegations are pouring into Washington and it is Mr. Britton's opinion that there is no chance for an open Sunday fair.

Department of Manufactures.—James A. Allison, of Cincinnati, the very efficient Chief of the Department of Manufactures, was on Friday last granted a leave of absence for an indefinite period by Director-General Davis. Mr. Allison is suffering from nervous prostration, brought on by overwork in directing the erection of the magnificent building and in the assignment of space in his most important department. It is hoped that a few weeks spent in Florida, where he has gone with a party of friends, will restore him to his accustomed good health. In accordance with civil service rules, and on account of his special fitness for the place, Mr. Frank Williams, Mr. Allison's assistant, will take charge of the department until the return of his chief. Mr. Williams has been for several years Chief Inspector of Manufacturing Statistics in the Census Bureau at Washington. The office was removed to Jackson Park on Saturday last.

The Meteorology Congress.—During the latter part of August next, commencing on the 21st regardless of the weather, there will assemble in this city a body of distinguished men, experts in meteorology, climatology and kindred subjects. It will be known in history as the general division of meteorology, climatology and terrestial magnetism, an advisary council having been formed to conduct the congress. Mark W. Harrington, chief of the United States Weather Bureau at Washington, is chairman of the committee on arrangements, with Sergeant N. C. Frankenfield, in charge of the Chicago weather station, as vice-chairman. In calling attention to the benefits to be derived Chairman Harrington says that it will be the object of the congress to briefly review the progress that has been made up to the present time in every branch of meteorology and its application to agriculture, navigation, engineering, hydraulics, windmills, etc., and its bearings on questions of geology, and the acclamatization and distribution of plants and animals. Even the connection between meteorology and the magnetism of the earth, the earthquakes, the volcanoes of the earth, the meteoric shooting stars, the aurora and the varying condition of the sun, all have their place in such a discussion. Noted men from every civilized country on the globe will be present, and it is expected that progress in the future in meteorological work will be greatly facilitated by a comprehensive discussion of the present status of this branch of applied science.

Souvenir Coins.—The Secretary of the Treasury on Thursday last authorized the delivery of $33.000,000 in souvenir fifty-cent pieces to the World's Fair Directory, that being the amount of expense vouchers so far approved by the department. These coins reached Chicago late Saturday afternoon last. Regarding their distribution, after the first five thousand had been checked out to the Jennings Trust Company, for Thos. B. Bryan, Sub-Treasurer, John R. Tanner said: "I have taken it for granted that the distribution would be made through the department, but have received no official notice to that effect. I even petitioned the last Congress for additional help in consideration of the extra burden to be thrown on this office by the distribution of these coins." Lyman J. Gage, of the First National Bank, in an interview said: "We are somewhat disappointed over the delay in the first shipment of coins. The only place for the public to get these coins is at the Exposition company's office, where subscriptions may be made. The First National Bank has subscribed for 13,000 pieces, which will be delivered to our customers who have paid for them. Other banks have undoubtedly made similar arrangements for distribution to the public. We are entitled to 1,500,000 pieces of this money, and other shipments will follow close on the heels of this first one." Last August, when the management decided it would not sell the coins in fewer than lots of 50, Mr. T. B. Bryan thought many small shareholders would be unable to secure a souvenir if they had to purchase fifty. So purely as an accommodation to the small shareholders, he drew his check for $5,000, the Jennings Trust Company pledging the distribution without cost. This particular lot has all been subscribed for, and as Mr. Bryan's was the first order, these subscribers will get the first coins. Orders have been issued for the coinage of these pieces as rapidly as possible, and it is estimated that several hundred thousand of them will bear the date of 1892. Treasurer Seeberger is having an active demand for the souvenir coins for Christmas gifts and it is possible that thousands of the first consignment will be used for that purpose.

FIG. 4.—A PROPOSED ELECTRIC TRICYCLE FOR THE WORLD'S FAIR GROUNDS.

The methods of transportation to be adopted for the moving of passengers on the World's Fair Grounds next year will be very generally electrical. Some of these as now either proposed or actually in process of construction are shown on this and the preceding page. Fig. 1 is a view of the lagoon showing the Administration Building in the distance with a number of electric launches in the foreground. Fig. 2 is a perspective view of the elevated electric road now in process of construction across the grounds. Fig. 3 is a method of transporting passengers along the Machinery Hall by electric cranes similar to those used at the Paris Exposition. Fig. 4 is a view of one side of the Electricity Building with a proposed electric tricycle in the foreground. Fig. 5 will be recognized as the well known type of electric elevator which will find extended use in a number of the buildings on the Fair Grounds.

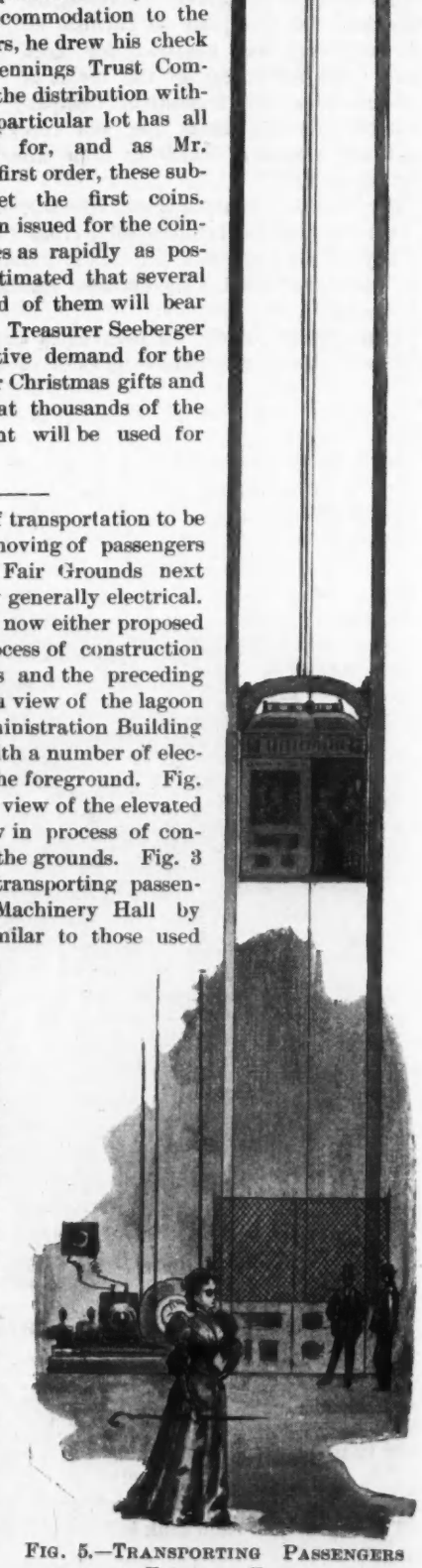


FIG. 5.—TRANSPORTING PASSENGERS BY AN ELECTRIC ELEVATOR.

One of the most interesting pieces of apparatus in Machinery Hall will be the large traveling cranes, similar to that shown in Fig. 3, operated by electricity on immense tracks 1,500 feet long, each crane weighing 50 tons and capable of picking up with ease a weight of 20 tons, when not in use for passenger service.

Series Electric Traction: A Reply to Dr. Cary T. Hutchinson.

BY NELSON W. PERRY.

I emphatically protest against being accredited with sentiments that do not belong to me. In his reply of Dec. 10 Dr. Hutchinson repeatedly puts statements in my mouth that I have not used in this argument, and then proceeds with great unction to demolish those statements. That is a line of argument both disreputable and unfair.

In his alleged reply to my letter of Dec. 3, Dr. Hutchinson divides up his remarks under numerous suggestive headings. In this letter I shall use the same to facilitate reference should any one care to follow this argument closely. He says:

Mr. Perry's letter in the issue of THE ELECTRICAL WORLD for Dec 3 scarcely calls for a reply, since nearly all my statements quoted there are admitted to be correct, etc.

This is certainly complacent, and if he believes it he is a person of duller comprehension than I give him credit for. The fact is, I claim that he has undertaken to criticise a system, the description of which he has not read carefully, and which he does not understand, and having condemned it assigned reasons therefor, none of which are valid, and that in the arguments he has used he has made himself ridiculous before the public. He has already had to retract most of his statements, and now, as a last resort, in order to make it appear that he has some ground to stand on, attributes to me certain statements of his own choosing, refutes these and hopes to pose before the public as one who has at least won some points in the argument. It seems to me that one who undertakes to criticise a paper, as Dr. Hutchinson has mine, should do that paper the courtesy to read it thoroughly first.

Movable Switches.—He speaks of the Perry series system involving "switches placed somewhere on the exposed structure of an electric line and operated directly or indirectly (he doesn't know which) by the passage of a car."

If he had read the brochure descriptive of the Perry system, he would have seen (p. 3, bottom) that in describing a former attempt in this line I have given this feature as characteristic of the system and that I condemned it also. In the Perry system the switches are not placed anywhere on the exposed structure, and are not operated either directly or indirectly by the passing car. They are placed in hermetically sealed or weather proof boxes on the poles at the side of the street, or might, with equal efficiency, be placed on marble tables in the parlors of the adjacent houses. Now Dr. Hutchinson can make his choice of locations, and if he should find a suitable one, would he not then grant that the "double or triple winding" on account of which he condemned this system, was in reality "an excellent thing?"

Trolley "Wheels."—To set all doubt at rest on this subject, and to enable Dr. H—— to pass intelligently on the Perry system, I will say that my trolley consists of a trolley wheel running upon the straight trolley wire, as in the usual method. This wire is broken electrically between sections, but the gap is filled with some insulating material so as to make the path of the wheel perfectly continuous and smooth. At the side of the wheel, and electrically connected with it, are small brushes, which wipe the short subsidiary wires found at each section terminal, but are at other times idle. As before stated, these short subsidiary wires may be less than a foot long; in fact, need only be long enough to pass current to the switches for a sufficient time to excite the magnets.

Forty Ampères.—Dr. Hutchinson would have us believe that the Perry system is limited to the use of 40 ampères, because he places that as a limit to the current practicable to use in operating the switches. One thousand ampères could be used on the line, if necessary, and still but 40 or 20 or 10 or 1 be employed to operate the switches, and Dr Hutchinson is too good an electrician not to know this. His statement is probably an inadvertence. In the Perry system nothing is used simply "because it has been used before," and much is not used for that very reason.

Sectioning the Line.—He says "It blocks the line and necessitates the cars being kept a certain minimum distance apart." He objects to this. Most people, I think, would regard it as highly advantageous.

On steam roads many ingenious devices have been brought out to accomplish this very thing, but the best means thus far seem to be to let each train as it passes set a signal and then trust to the engineer of the following train not to pass that signal until another one is set permitting him to pass. Nowhere, I think, would such a feature be more desirable than on Tremont street, Boston, where, as he says, the cars almost join one another. Whatever Dr. Hutchinson may think, I regard this statement of his (and he is a high authority) as a very high compliment to the system. He should have worded it a little differently, however. "It blocks the line and keeps the cars a certain minimum distance apart" would be better and more nearly true.

Overloads.—I suppose he intends to be facetious when he speaks of patrons getting out and pushing on heavy grades. It is certainly an argument fully the equal of some others he has used.

Double Trolley.—Dr. Hutchinson's bringing in the Supreme Court of Ohio has no bearing whatever on my statement. I merely stated that the double trolley was not so palpably bad that a certain bright and able judge could be convinced that it was bad. If it was as bad as Dr. Hutchinson would have us believe, there would have been no difficulty in this. Nor do I see from his quotation that the Supreme Court thought it bad; it thought the single trolley more simple—that's all. It matters not what the reason of the introduction of the double trolley in Cincinnati was, the *fact* remains, that from 50 to 75 miles of it are being most successfully operated there, probably as cheaply as, if not more cheaply than, the single trolley, demonstrating that the fact that the Perry system is a double trolley system, was no warrant for Dr. Hutchinson saying that for that reason it could run nowhere except on paper. Besides I have shown in my paper that the objection to the double trolley as employed in the constant potential system does not hold in the series system.

Claims to Merit.—Lord Kelvin, as quoted by Mr. Perry, states that there is a saving in copper by the use of high potentials. I made no such quotation. I quoted Lord Kelvin as saying that "where power is to be transmitted to long distances, the method by constant current is a much more economical method than that by constant potential."

"Constant current machinery is not cheaper than constant potential; an arc light dynamo costs about $40 per h. p., while a constant potential dynamo can be bought for $30; nor is constant potential machinery as simple as the other." I made no reference to the relative costs of machinery of the two kinds as implied above, but statedthat "as to the cost of installation, the comparison is much in favor of the constant current method on account [as he admits] of the extreme simplicity of the plant required, and the smaller size of both motors and dynamos for the same output." I presume that a constant current plant to operate a given number of cars could be equipped at not to exceed 75 per cent. of the cost of an equivalent constant potential plant. It would occupy less ground space and could be placed where land was cheap and fuel and water most easily obtained, whereas the location of a constant potential plant is determined by the line of the road, whatever the cost of the land, and whether fuel and water be cheap or not.

But Mr. Perry, although quoting figures from Mr. Sprague's paper, has strangely enough failed to see the following sentence, even though it is in italics: "With the Sprague system nearly every motor coming to a stop or running on a down grade becomes a generator which is helping to supply the current needed to operate the remaining trains."

I made no reference to or quotation from Mr. Sprague's paper whatever either in my original paper or in my former communication to THE ELECTRICAL WORLD, but I am willing to admit the statement into the argument. I know of but two ways in which a car operated by the constant potential method can be braked electrically. The first is by reversing, which would most certainly burn it out, but assuming that it didn't, it could only contribute current to the line when the potential generated by the motor equaled or exceeded that of the line, and second by letting it run and depending upon the armature field reaction for retardation. In the latter case current would be contributed, but in very rapidly decreasing quantity as the speed was slowly checked. The average contribution would be so small, however, as not to be worth the "complication."

In the series system, however, every time the car lessened its speed, every time it stopped, every time it descended a grade at less speed than that due to gravity, the energy represented by the retardation would be thrown on the line. Thus a hilly line is practically reduced to one on a level, a trip of frequent stops is reduced to one of continuous running, and the energy now thrown away on the brakes, instead of being a source of expense may be made to do duty in paying dividends, and this without "complication." Dr. Hutchinson admits that this can be done, but adds "how far remains to be proved."

If a motor can be run as a generator by a steam engine, it can be run with equal efficiency by the momentum of the car or by the weight of the car descending a hill. Its practicability was demonstrated by Prof. Short in St. Louis, and it has been shown at Northfleet, England.

Turnouts can be made on a single track road by the Perry system, and cars may pass from one system of roads to another with the same facility as with the constant potential system. A single trolley pole may be used with two wheels at the top, and with trolley wires but three or four inches apart. It may be so constructed, with a guide between the wheels, as to be less likely to leave the wires than the single trolley, and, when it does leave the wires, with no less disastrous results. By the Perry system, if there were 20 cars on the line, all but one might leave the wires, and that one continue running as though nothing had happened, and, when it became necessary to replace the trolleys, the guide would enable it to be done without the fishing around usually so necessary on the single trolley constant potential roads.

An engineer who is not sure that his bridge will stand until it is erected is not much of an engineer.

A Mammoth Electric Transfer Table.

One of the first exhibits to be installed upon the World's Fair grounds is a large transfer table now being erected in the annex to the Transportation Building. This table is designed by Wm. J. Trott, the electrician of the Bay City Industrial Works, Bay City, Mich. The reason that this exhibit is being installed so early is that it will be used to place in position all railway exhibits, after which it will be shown as one of the regular exhibits. The length of this table is 70 feet, its width 14 feet and its capacity 100 tons. The table itself weighs about 40 tons. The motive power consists of one 30-h. p. Thomson-Houston W. P. motor with a standard Thomson-Houston regulator and reversing device. Power is transmitted through a set of cut gears to the shaft carrying the wheels on which the table rests by means of friction clutches. The speed may be varied from 250 to 500 feet per minute. By the same means the drum is operated, which is used to shunt the cars off and on the table as may be desired. Current is supplied by the double trolley system, the wires being placed in a pit below the table. The voltage used is about 500.

Non-Polarized Ammeters.

BY CLARENCE E. GIFFORD.

I desire to call the attention of the readers of THE ELECTRICAL WORLD to the danger accompanying the use of non-polarized ammeters for the main or machine ammeters in power stations.

The danger lies in the fact that instruments of the non-polarized type give always deflections in the same direction, regardless of the direction of the current.

Take the case of two or more shunt wound machines working in multiple, or of compound wound machines in multiple.

Trouble may originate primarily from carelessness, in attention or inexperience of the switchboard attendant, or it may arise from a change in the relative speed of the engines during a momentary period of very light load, or again, it may come from a disproportionate lowering of the temperature and resistance of one of the rheostats, from exposure to strong drafts of air during a period of very light load.

Suppose that during a period of this kind the voltage of any machine of a group falls, from any cause, to such a point that the output from that machine is nil. The index of the ammeter falls back to zero. If this escapes the notice of the attendant the pressure from this machine may in another moment have fallen to such a point that the machine is receiving current and running as a motor.

Remember, in this connection, that a compound wound machine, when properly connected for operation as a dynamo, is a somewhat unruly machine when used as a motor.

Even the provision of equalizing wires, as where this class of dynamos are worked in multiple, does not, unless said equalizing wires are of exceedingly low resistance, entirely obviate the evil effects of the series winding on a compound dynamo that once decides to start in business as a motor. In other words, so long as a dynamo is producing ever so small an output (whatever the output of its companions) just so long the series windings, working in connection with the equalizing wires, will operate in their legitimate manner, and tend toward effecting a uniform voltage in the various machines of the group. But when the output of one of our machines gives place to an income of current, the income of the owners of the plant is sometimes affected in an inverse ratio.

Returning after this digression to the point where one of our dynamos became a motor. Its ammeter leaves the zero point and indicates an amount of current which the attendant innocently supposes to be output. This may soon give a reading exceeding the output of any single one of its companions. The attendant "regulates" the machine by throwing the resistance into the shunt field; the ammeter, somewhat to his surprise, goes farther ahead of its fellows; he regulates some more, and the ammeter takes another jump; he gets excited, and there follows a race between him and the wheel of the rheostat on the one hand and the ammeter on the other; and, before the range of the rheostat is reached, the engine joins in the chase, because its dynamo is now operating with such power as a motor that the engine will be pulled through at a high speed, her governor being simply capable of limiting the steam supply within certain limits, but beyond such limits being of no avail in counterbalancing the power of the motor.

Meanwhile, suppose, in addition to your "self-imposed" burden, that a heavy line load has come on—Results: blown fuses, overloaded dynamos, lines shut down, new fuses and new and probably fruitless attempts to regulate—Bedlam in the station, and the "devil to pay" generally. Query: Why didn't you apply your voltmeter to the troublesome machine? Well personally, I never had the above sad experience, but any one who knows the ordinary ways of a power station will be able to answer the question, and will also be readily able to see how a combination of high ammeter, low voltmeter and run-away engine might be a somewhat difficult problem for a man of even good ability. Remedy: If you use non-polarized ammeters for your machines, put a brass strip across the front of the case, near the top, and from the centre of this strip pivot a vertical polarized steel bar or needle, the pivot being slightly above the centre of gravity of the needle. The needle should be of good magnet steel, well charged, and so pivoted as to move very easily.

Then, if the current passes in the same direction through all your ammeters when the machines are in proper operation, the polarized needles will, of course, all be deflected in the same direction, one with another; and any deflection to the opposite side of the vertical line will indicate that the dynamo to which it belongs is being run as a motor.

The Incandescent Lamp Patent Case; Full Text of the Opinion.

United States Circuit Court of Appeals, for the Second Circuit: Edison Electric Light Company and Edison General Electric Company, Appellees, vs. Sawyer-Man Electric Company, Appellant.

Kerr & Curtis, solicitors for appellant; Edmund Wetmore, Elihu Root and Leonard E. Curtis, counsel for appellant; Dyer & Seely, solicitors for appellees; Clarence A. Seward, Grosvenor P. Lowrey and Richard N. Dyer, counsel for appellees.

Before Wallace, Lacombe and Shipman, Circuit Judges.

Per Curiam:

This is an appeal from an order of the Circuit Court granting an injunction pendente lite restraining the defendant from making, using, or vending the incandescent electric lamps of the patent granted to Thomas A. Edison, January 27th, 1880, No. 223,898, of which the complainants are the owners. The order was granted pro forma, in the view that a final disposition of the questions involved might be promptly made by the decision of this Court.

The validity of the patent, and the infringement of its second claim by such lamps as the defendant makes, were adjudged by the Circuit Court for the Southern District of New York, July 14, 1891, in a decree at final hearing. That suit was brought against the United States Electric Lighting Company, and was defended by the Westinghouse Electric Company, a corporation which since October 10th, 1888, has been the owner of the business carried on in the name of the present defendant. The business of the defendant consists exclusively in the manufacturing of the infringing lamps. The decree of the Circuit Court adjudging the validity of the second claim of the patent, and its infringement by lamps such as are made by the defendant, was, upon an appeal, affirmed by this Court, October 4th, 1892. That decree, among other things, awarded the complainants a perpetual injunction. The present suit was brought subsequent to that affirmance.

It is apparent that the order for the present injunction is in effect one to extend the terms of an injunction already granted in a suit determined by the Court of last resort between the same parties, or their privies, so as to include a new infringement. For an understanding of the grounds upon which the defendant contends the injunction ought not to have been granted, the following narrative is necessary:

For several years subsequent to 1880, the Edison Company and the United States Electric Lighting Company were the only manufacturers of incandescent lighting apparatus in this country doing any considerable business. The United States Electric Lighting Company began manufacturing incandescent lighting apparatus, including the lamps which have been held to be an infringement of the Edison patent, in the summer of 1880, and continued in such business until a recent period. In May, 1885, a suit was brought against it upon the present patent. Another corporation, Consolidated Electric Lighting Company, was organized in September, 1882, and began the manufacture of incandescent lighting apparatus. This company was the owner of and operated under what are known as the Sawyer-Man patents for electric lighting apparatus; and under these patents it assumed that it had the exclusive right to make and sell the lamp claimed in the patent in suit. In May, 1885, suit was brought against it by the Edison Electric Light Company upon the patent in suit, and about the same time it brought suit against the Edison Company for infringement of its own patent. In 1883 a corporation known as the Thomson-Houston Company began the manufacture and sale of electric apparatus for lighting and power. As the result of negotiations between the Consolidated Electric Lighting Company and the Thomson-Houston Company, the Sawyer-Man Company, the present defendant, was organized in September, 1886. Nine-tenths of its stock was owned by the Thomson-Houston Company. It received from the Consolidated Company a license to manufacture lamps under the Sawyer-Man patents, and thereupon began the business of manufacturing the infringing lamp, and has continued in this business to the present time. In August, 1887, all the stock of the defendant, including that owned by the Thomson-Houston Company, was sold to the Consolidated Company for $120,000 in bonds, and the same amount at par of its stock. In December, 1888, the Thomson-Houston Company sold its stock in the Consolidated Company to the Westinghouse Electric Company. At the same time, by an agreement between the Consolidated Company and the Westinghouse Company, the fulfillment of which on the part of the Consolidated Company was guaranteed by the Westinghouse Company, the Thomson-Houston Company was licensed under the patents of the Consolidated Company to make incandescent lamps for export and use with generating apparatus of its own manufacture in this country; and the Westinghouse Company was prohibited from selling incandescent lamps for use with the Thomson-Houston generating apparatus for a period which might, at the option of the Thomson-Houston Company, extend to 1902. The agreement recognized the fact that the Thomson-Houston Company could, during the continuance of the agreement, make and sell lamps not covered by the Consolidated Company's patent; and in the event of such manufacture and sale, the latter company was released from its obligation not to sell lamps for use in connection with the Thomson-Houston generating apparatus. Pending the suit against the United States Electric Light Company, the Westinghouse Company succeeded to the business of the United States Company, the Consolidated Company and the defendant; and since September, 1888, the defendant has been the manufacturer of lamps for the Westinghouse system. Each of the various companies engaged in the manufacture and sale of electric lighting apparatus, has, as a rule, manufactured all the different pieces of apparatus which are necessary for making up a complete "plant," the different parts being constructed with reference to use with each other, and not so as to be adapted for use in the systems of apparatus made by other manufacturers. For the purpose of public lighting from central stations local companies, known as illuminating companies, have been organized in various cities and towns, which have purchased plants from one or the other of the manufacturing companies, and the central stations of such illuminating companies have, as a rule, been equipped wholly with the electrical apparatus made by some one manufacturing company. In many cities and towns there are competing illuminating companies, using the system of different manufacturers, some being equipped with the Edison system, some with the Westinghouse system, and some with the Thomson-Houston system.

The United States Company has installed about 1,050 plants, with a lamp capacity of about 350,000 lamps. About 300 of these plants were installed before the suit upon the patent was brought against it. The Consolidated Company also installed a large number of plants. After the Westinghouse Company succeeded to the business of the United States Company and the Consolidated Company, it also installed a large number of plants.

It is said that the aggregate lamp capacity of the incandescent lighting plants installed with generating apparatus supplied by the Westinghouse Company at the present time represents a capital of about twenty-five millions of dollars, and a lamp capacity of over 1,300,000 lamps. The lamps themselves represent but a small part of the cost of the plants, the greater part being represented by the electric apparatus supplied by the Westinghouse Company and its predecessors; but the lamps are essential for the continued operation of the plants. Unless the lamps can be replaced as they are worn out, and can be procured when needed, these plants will be crippled and the greater part of the investment in them will be lost. The central station plants supply lights to consumers as gas companies supply gas; and if their operation should be stopped great inconvenience to the public would ensue. The various companies give employment to a large number of men, who might be thrown out of employment if the lamps could not be obtained.

In 1889 the Edison General Electric Company was organized for the purpose of combining the Edison Electric Light Company with various other corporations engaged in the manufacture and sale of electric apparatus, the organization of the subordinate corporations being retained. Prior to April, 1892, the Thomson-Houston Company had acquired the stocks of various other companies engaged in the business of manufacturing and selling electrical apparatus, and these companies were carrying on the business in combination with the Thomson-Houston company and under its control. In April, 1892, these two combinations, the Edison General Electric Company and the Thomson-Houston Electric Company, included substantially all the companies which had theretofore been competing in this kind of business, excepting the Westinghouse Company; and in that month the General Electric Company was organized for the purpose of combining these two combinations in one which should include all the concerns in this country, except the Westinghouse Company, which formerly were competing in the business of making and selling electric light and power apparatus; but the separate organization of the constituent companies was still retained.

The defendant insists that the preliminary injunction should not have been granted because; (1) owing to the laches of the owners of the patent in asserting their claims and enforcing them, a large capital has been invested in the manufacture and sale, not only of the lamps, but also in electric lighting apparatus, which will be greatly depreciated in value unless the lamps can be used with it, and that an injunction will cripple and perhaps ruin the local illuminating companies who have invested in the plants of the Westinghouse companies if they are prevented from using the lamp of the patent, and thereby subject to great inconvenience those whom these plants furnish with light, and displace a large number of persons who are employed in operating the plants; (2) because the complainants and the other corporations with whom the complainants are associated, the competitors of the Westinghouse Company in the business of making and supplying electric power and lighting, have entered into an unlawful combination to stifle competition in that business, and an injunction will be used unconscionably to further the objects of the combination; and (3) because by reason of the affiliation of the Thomson-Houston Company with that combination, and the prior dealings of that company with the defendant, the Consolidated Company and the Westinghouse Company, an equitable estoppel has arisen by force of which the complainants, as parties to the combination, ought not to be permitted to have an injunction. The question whether there has been any laches in asserting the patent was considered by the Circuit Court of Appeals upon the appeal from the decree of the Circuit Court, and that court declared that no case was shown to authorize the refusal of an injunction on any theory of laches or equitable estoppel by reason of undue delay in bringing suit, or acquiescence in known infringement. If the owners of the patent proceeded with due diligence as respects the United States Lighting Company, no other infringers of the patent can be heard to complain with reason that suit was not brought against them upon the patent previous to the adjudication of its validity in the Circuit Court. It is a matter of notoriety that that litigation was a very expensive and arduous one; and its progress must have been familiar to all those who were extensively interested in having the patent defeated. As regards the present defendant, there are no new facts of importance bearing upon the question of laches to distinguish the case from that shown in the former suit. We see no reason for changing the opinion expressed by this court in the former case, and do not deem it necessary, because the same defence has again been urged upon substantially the same state of facts, to add anything to that opinion.

Every one of the manufacturing corporations, the competitors of the Edison companies, commenced their operations with a knowledge of the existence of the patent in suit. They were controlled by business men of intelligence and experience. Their promoters and managers may have believed, and probably did, that the patent could not be successfully maintained. But they entered upon the business with an understanding of its risks, and of the consequences which would befall them as infringers, if the patent should be sustained. None of them can now be justly heard to say that an injunction which is essential, if not indispensable, to the protection of the owners of the patent and their licensees, ought not to be granted because of the great pecuniary loss which may result. If in consequence of being deprived of the use of the lamps, their investments in other electric apparatus will be greatly depreciated, they must take the consequences.

The users who have supplied themselves with electric lighting plants from the infringers, which required for their operation lamps of the patent, are of course infringers. But those who did so before the decision of the Circuit Court sustaining the patent, and at a time when judicial decisions in foreign countries interpreting the patent were in conflict, and who are now willing to accept their lamps from the complainants upon reasonable terms, have much stronger equities than the manufacturing infringers. These equities the court will not disregard; but what would be reasonable terms, if an application were made to the court on behalf of these users, is a question, which can only be determined in each case upon its particular circumstances.

As to those users, however, who have acquired these plants subsequent to the decision of the Circuit Court, if they are deprived of the use of the lamps, and as a consequence the value of their plants may be greatly impaired, they must accept the result as a consequence of their own imprudence.

We are not disposed to investigate upon the present case the character of the combination which has been formed under the name of the General Electric Company. Whether that combination is intended to fetter competition, and is illegal as one in restraint of trade, is a question which we should not undertake to decide upon the evidence before us and in a suit to which it is not a party. The present complainants are entitled by the patent laws to a monopoly for the term of the patent of the manufacture and sale of the lamps made under it; the right to this monopoly is the very foundation of the patent system. They do not lose that right merely because they may have joined in a combination with others, holding other patents securing similar monopolies, which combination may, when judicially examined in a proper forum, be held to be unlawful. We do not feel justified in assuming upon the facts before us in the present suit that the use which the complainants propose to make of the injunction, an injunction which seems necessary to secure their monopoly and make their patent fruitful, will be such as to promote any other monopoly. When it shall be made to appear that some one, to whom in fairness and good conscience these complainants should sell their lamps, has been arbitrarily refused them, save upon oppressive and unreasonable terms, it will be time to consider whether the complainants should be allowed to continue in possession of the injunction.

The alleged estoppel seems to be far-fetched and shadowy. The history which has been given shows that before the Sawyer-Man Company was organized litigation upon the patent in suit and upon the Sawyer-Man patents had commenced; that in 1887 the stock in the Sawyer-Man Company owned by the Thomson-Houston Company was sold to the Consolidated Company, a party to the suits; and that, subsequently, in 1888, the Westinghouse Company, an actual party to the litigation,

bought that portion of the stock from the Consolidated Company which had been owned by the Thomson-Houston Company. The estoppel lacks the elements which ordinarily create an estoppel in pais, namely, an injury or a harm to one person resulting from a reliance upon the acts, conduct or declarations of another, in which there was an element of bad faith or wilful neglect of duty. The history of the connection of the Thomson-Houston Company from 1886 to 1888 with the Consolidated Company, and with the Sawyer-Man Company, the defendant, shows that all these companies knew of the existence of the litigations in which the life of the present patent and of the Sawyer-Man patent was at stake. There can be no charge of concealment or constructive fraud. When the sale and the agreement of 1888 were made, there was no implied obligation upon the Thomson-Houston Company to remain in alliance with the Westinghouse system. The contingency that it might enter upon the manufacture of competing lamps was contemplated. Its union with the Edison interests has neither hastened nor facilitated the application for the present injunction. We perceive no adequate reason from the facts why the complainants should not obtain the ordinary results which attend a complainant's success in a suit in equity for the infringement of a patent.

The injunction order appealed from should be modified so as to cover only lamps made in infringement of the second claim of the patent, the other claims not having been infringed according to the adjudication of the Circuit Court or of this Court. It should also contain a provision reserving the right to the defendant to move hereafter for the vacation, suspension or modification of the injunction upon proof of specific instances of refusal on the part of the complainants, or either of them, to supply the lamps of the patent upon terms reasonable under the circumstances of the particular case, to the owners of electric lighting plants which were installed before the rendition of the interlocutory degree of the Circuit Court sustaining the validity of the patent.

Legal Decision Regarding Contract for Personal Services.

Supreme Court, First Department, General Term, November, 1892.

Charles H. Van Brunt, P. J.; Morgan J. O'Brien, George C. Barrett, J. J.

The W. J. Johnston Co., Ltd., appellant, vs. Walter T. Hunt and The Electrical Age Publishing Co., respondents.

Appeal from the judgment of Special Term dismissing complaint.

O'Brien, J.

This action was brought to obtain an injunction restraining the defendant Hunt from working for the defendants, The Electrical Age Publishing Company, in the capacity of advertising solicitor or agent, and for damages on the ground that Hunt had agreed "to devote his entire time and attention to the interests of the Johnston company in the capacity of an advertising solicitor and to do similar work for five years from the first day of June, 1890."

Upon the trial the written agreement between the parties was produced. By its terms, in addition to the provision above quoted, it further provided that the defendant Hunt while in the employment of the plaintiff would not "devote any of his time or attention during the business hours or otherwise in the interests or to the advantage of any other corporation, company, person or firm, electrical or otherwise, without the written consent" of the plaintiff.

This agreement, as shown by the testimony was wantonly and without any just cause or excuse broken by the defendant Hunt, Being dissatisfied with the former agreement entered into between them, he induced the plaintiff to cancel same and further induced him to pay $4,000 in cash and thereupon executed the agreement which it is now sought to enforce against him.

Upon such a state of facts, and concededly out of no consideration for the defendant Hunt, whose bad faith was made apparent, the learned trial judge dismissed the plaintiff's complaint, upon the ground that the contract was of such a nature as not to entitle the plaintiff to an injunction restraining the defendant Hunt from giving his services to the other defendant, who it appears carries on a paper similar to that conducted by the plaintiff, and in competition with it. The question thus presented as stated in Daly vs. Smith (38 Supreme Court; 58 Howard's Practice, 150) is whether or not a court of equity will interfere by injunction to prevent a breach of a contract for personal service, or whether the complainant must look to his damages at law as his sole redress. This case of Daly vs. Smith, as well as all cases germane to the subject, observe the distinction which is to be noticed between affirmative and negative covenants in such an agreement, and while the court does not possess the power to compel a person to render service which he has agreed to perform, yet when he has stipulated not to work for another the court can and will in a proper case prevent his doing so.

It is not, however, in all cases where contracts are made for personal services, that a court of equity will intervene but only in cases as stated in Pomeroy's Equity Jurisprudence, Vol. III., Section 1,343, where "a contract stipulates for special, unique and extraordinary personal services or acts to be rendered or done by a party having special, unique and extraordinary qualifications, as for example, with an eminent actor, singer, artist and the like."

As stated by Mr. Justice Barrett, in Strowbridge Company vs. Crane (35 St. Rep., 473) "it may sometimes be difficult to say just what is special, unique and extraordinary service or whether the employee possesses special, unique or extraordinary qualifications. The solution may generally be reached by the inquiry as to whether a substitute for the employee can be readily obtained, and whether such substitute will substantially answer the purpose of the contract. In other words, whether the individual service specially contracted for is essential to prevent irreparable injury. The foundation of jurisdiction is the inability of the law to afford adequate relief."

By the evidence in this case it is shown that the plaintiff immediately after the defendant had broken his contract substituted in his place another, and while there is some slight evidence to show that the effect of the withdrawal of the defendant Hunt and the substitution of another resulted for the time being in some loss of advertising to the plaintiff's paper, yet it fails to establish what is required in cases of this kind, viz., that the injury was irreparable and not capable of being ascertained and redressed by a suitable action at law and that Hunt possesses "special, unique and extraordinary qualifications as an advertising agent or solicitor." There can be no doubt that his services were valuable, because this is evidenced by the character of the agreement, the efforts put forth by the plaintiff to retain his services and the consideration provided in the agreement for his compensation. Regarding, however, the character of the work which he was to perform and the other considerations adverted to we do not think that there is presented a case which should demand the equitable interposition of the court.

The appellant, however, urges and with much force that however the court concluded upon the evidence that the plaintiff was not entitled to equitable relief, still having the action for one purpose and it being shown that damages resulted by reason of the defendant's breach of the agreement the court could have proceeded to ascertain the same or send the case to a referee or jury for that purpose.

This question has been many times presented, and we do not pretend to reconcile the cases; and, while there is seeming authority for the position taken by the appellant that it is within the power of the court in an action in which both equitable and legal relief are sought upon the same state or fact to retain the action and dispose of the question of the legal relief as though the action had originally been brought only for such relief, yet we find no case which goes to the extent of holding that a court upon reaching a conclusion that no equitable relief should be granted must retain the action for such legal relief.

In determining the question as to when the discretion vested in the court should be exercised, we think it is properly employed by retaining the case for the purpose of affording legal relief in cases where at the time of the commencement thereof the facts warranted legal relief and would have justified a decree in equity, and whereby reason of a change in facts or circumstances subsequent to the commencement of the action such equitable relief is no longer necessary, or upon the facts proved upon the trial could not be granted. In such cases, the plaintiff having properly brought his suit in equity, should not, by reason of subsequent events, be denied relief, it being a proper exercise of discretion vested in the court to retain the action for the purpose of disposing of the question of legal relief in the manner provided for the trial of legal actions, thus saving the delay, labor and expense incident to the commencement of another action at law. On the other hand, where a suit is brought in equity and the evidence discloses the fact that at the commencement thereof the plaintiff was not entitled to any equitable relief, then the court, upon dismissing the equitable claim, can require that the plaintiff take any other relief to which he may be entitled, must proceed in the ordinary way by an action at law.

Having concluded that the plaintiff was not entitled to the injunction prayed for, and that as to this part of the relief the complaint should be dismissed, the trial judge was then not obliged, even though a motion was made by the plaintiff to that effect, to send the case to a referee or to the Circuit Court for trial, but could, as he did, dismiss the complaint without prejudice to an action at law.

We are of the opinion that the judgment should be affirmed with costs.

DISSENTING OPINION.

Barrett, J.

I dissent upon several grounds.

First. The learned judge at the Special Term should not have dismissed the complaint upon the ground that jurisdiction in equity was not general, when no point was taken by counsel. The defendant moved to dismiss upon other grounds, and the learned judge, without passing upon these grounds, dismissed the complaint generally, assigning as a reason that the remedy was at law.

Second. The defendant did not insist in his answer or suggest upon the trial that an adequate remedy at law existed. On the contrary, he treated the action throughout as properly an equitable one, and even demanded in his answer equitable relief as against the plaintiff.

Third. Upon the case made by the plaintiff and the proof that the contract was for the performance of personal service requiring specific aptitude, skill and experience, for the breach of which an action at law would not have afforded the plaintiff an adequate remedy.

The plaintiff's revenue comes almost entirely from advertising. Hunt was an advertising solicitor and controlled this advertising to a large extent personally. This was because a large proportion of such advertising was obtained through his personal solicitation. He had been in the employ of Mr. Johnston, or the plaintiff, for several years, and he grew up, so to speak, with the journal which they published. The business was built up with Mr. Johnston's or the plaintiff's money, which was expended for Hunt's salary and traveling expenses when engaged in the business of soliciting advertising. When Hunt notified Johnston he was about to leave, he said that it was personally owing to his services that the business was what it was, and that at least a portion of the business ought to belong to him. He at least must have felt that his services were "special, unique and extraordinary," for he shamelessly demanded $10,000, and declared that if it was not paid he would break his contract, connect himself with another journal, and take away half of the plaintiff's advertising business. In his answer Hunt did not deny the allegation of the plaintiff that

"By reason of his long connection with the plaintiff's said newspaper he had become thoroughly familiar and well acquainted with the method of carrying on plaintiff's business, and specially with the method of carrying on his advertising business, and the methods of soliciting or securing such advertising, and with the customers and patrons of the said plaintiff."

Nor did he deny that the knowldge which he possesses on the subject of this special advertising was acquired while in the employ of Mr. Johnston, or the plaintiff.

In the same way he admits that his large and extensive acquaintance with the advertisers was formed by means of money furnished to him by Mr. Johnston, or the plaintiff, to enable him to secure for their benefit a business standing with persons, firms and corporations who needed to use the journal in question as an advertising medium.

His conduct in securing the advance of $4,000 in cash as an inducement to execute the new agreement under consideration, and in subsequently demanding $10,000 more as an inducement to be honest in fulfilling it, is properly characterized by Mr. Justice O'Brien. That at least there was certainly unique and extraordinary conduct, and it was based upon the undoubted fact that his services were essential to the plaintiff and that no substitute could be readily obtained.

I think the facts in this case bring it fully within the principle enunciated in Strowbridge Company vs. Crane (35 New York St. Rep., 473), which Mr. Justice O'Brien notes, and the authority there referred to, and that the judgment should be reversed and a new trial ordered.

The St. Louis Meeting of the National Electric Light Association.

From present appearances the St. Louis meeting of the association, to be held the latter part of February next, will be fully up to the standard of former meetings. Efforts are being made to arrange one of the best programmes yet given. Secretary Porter informs us that Mr. Sterling of the Consolidated Company, of Denver, Col.; Mr. Blaxter, vice-president of the Allegheny County Light Company, of Pittsburgh; Mr. A. W. Wright, vice-president of the Siemens-Halske Company, of Chicago, and Judge Armstrong of Camden, N. J., will, among others, present papers dealing with topics which they are best fitted to treat. It is expected that Mr. Nikola Tesla will give a lecture accompanied by experiments illustrating some of the phenomena of high tension alternating currents. It is also expected that Prof. Elihu Thomson, Mr. William Stanley, Jr., and Mr. Edward Weston will be present and take part in the discussions.

The Buffalo Electrical Society.

At a meeting of the Buffalo Electrical Society Mr. P. K. Stern read an interesting paper on electric heating, an abstract of which appears on page 404 of this issue. The attendance at this meeting shows that the society has opened the season with its old time enthusiasm.

At the next meeting Mr. Frank Kitton will deliver a lecture on magnetism, and at a subsequent meeting A. C. Terry will lecture on the subject of electric motors, treating it in a popular and elementary way. The society is considering the project of a series of lectures on electrical engineering, known as the University Extension Course. The members of the Buffalo Society of Natural Sciences are very much interested in this course of lectures and the prospects are that the plan will be eminently successful. The lectures will be delivered by one of the best electrical engineers in the State.

The following officers have been elected for 1892-1893: President, Frank Kitton; vice president, P. K. Stern; secretary, Astley C. Terry; treasurer, Samuel Stewart; librarian, John G. McNerny; executive committee, Frank Kitton, A. C. Terry, F. P. Jones, John P. Chapin, P. K. Stern, Samuel Stewart, F. A. Hallock and Geo. A. Burnett.

Chronological History of Electricity—Part II.—1800-1820.

BY P. F. MOTTELAY.

ANSTEEN (CHRISTOPH), Norwegian astronomer and physicist, embodies in his notable work, "Unter-suchungen über den Magnetismus der Erde. . . ." (Inquiries regarding the magnetism of the earth), the result of his extensive researches concerning terrestrial magnetism, the account of which is accompanied by a chart indicating the magnetic direction and dip at numerous places. This work which is said to have been practically completed in 1813 (Humboldt, "Cosmos," 1859, vol. v., p. 66) was translated by the celebrated Peter Andreas Hansen (Poggendorff, vol. i., pp. 1,013-1,015) from the original manuscript and published in German. It attracted much attention throughout the scientific world and so highly was it thought of that in almost all the voyages of discovery since undertaken, magnetic observations were mostly made according to its directions.

Through the "Encyclopædia Britannica" we learn that Hansteen's able work was first made known in England by Sir David Brewster through two articles in the *Edin. Phil. Journal* for 1820, vol. iii., p. 138, and vol. iv., p. 114, and that an account of his subsequent researches, drawn up by Hansteen himself, appeared in the *Edin. Journal of Science* for 1826, vol. v., page 65. It is also stated that the Royal Society of Denmark proposed in 1811 the prize question, "Is the supposition of one magnetical axis sufficient to account for the magnetical phenomena of the earth, or are two necessary?" Prof. Hansteen's attention had been previously drawn to this subject by seeing a terrestrial globe, on which was drawn an elliptical line round the south pole and marked *Regio Polaris magnetica*, one of the foci being called *Regio fortior*, and the other *Regio debilior*. As this figure professed to be drawn by Wilcke, from the observations of Cooke and Furneaux, Hansteen was led to compare it with the facts; and the result of the comparison being favorable, he was induced to study the theory of Halley, which had previously appeared to him wild and extravagant. The result of his researches, however, was favorable to that part of Halley's theory which assumes the existence of four poles and two magnetic axes. Hansteen's Memoir, which was crowned by the Danish Society, forms the groundwork of the larger volume which he published in 1819. In his fifth chapter, on the Mathematical Theory of the Magnet, he deduces the law of magnetic action from a series of experiments similar to those of Hauksbee and Lambert. . . . In determining the intensity of terrestrial magnetism Professor Hansteen observed that the time of vibration of a horizontal needle varied during the day. Graham had previously suspected a change of this kind, but his methods were not accurate enough to prove it. Hansteen, however, found that the minimum intensity took place between ten and eleven A. M., and the maximum between four and five P. M. He concluded also that there was an annual variation, the intensity being considerably greater in winter near the perihelion, and in summer near the aphelion; that the greatest monthly variation was a maximum when the earth is in its perihelion or aphelion, and a minimum near the equinoxes; and that the greatest daily variation is least in winter and greatest in summer. He found also that the aurora borealis weakened the magnetic force, and that the magnetic intensity is always weakest when the moon crosses the equator.

According to Dr. Whewell[1] the conclusions reached by Hansteen respecting the position of the four magnetic "poles" excited so much interest in his own country that the Norwegian Storthing, or parliament, by a unanimous vote provided funds for a magnetic expedition which he was to conduct along the north of Europe and Asia, and this they did at the very time when they refused to make a grant to the King for building a palace at Christiania. The expedition was made in 1828-30, and verified Hansteen's anticipations as to the existence of a region of magnetic convergence in Siberia, which he considered as indicating a "pole" to the north of that country. The results were published in Hansteen and Due's "Resultate magn. . . . ," ("Magn., Astron. and Météor. Obs. on Journey through Siberia") which appeared in 1863.[2]

A. D. 1819.——Hare (Robert), who was for 29 years professor of chemistry in the Pennsylvania University, publishes in Philadelphia "A New Theory of Galvanism, Supported by Some Experiments and Observations Made by Means of the Calorimotor . . . ," of which an English edition appears in London the same year.[3]

This apparatus, which has already been alluded to (Pepys, A. D. 1802), consists of sheets of zinc about 9 inches by 6, and of copper, about 14 inches by 6, coiled around one another nearly half an inch apart; there being in all 80 coils, 2½ inches in diameter, which are let down by means of a lever into glass vessels containing the acid solution. Dr. Hare observes:

> Volta considered all galvanic apparatus as consisting of one or more electromotors, or movers of the electric fluid. To me it appeared that they were movers of both heat and electricity; the ratio of the quantity of the latter put in motion to the quantity of the former put in motion being as the number of the series to the superficies. Hence the word *electromotor* can only be applicable when the caloric becomes evanescent, and electricity almost the sole product, as in De Luc's and Zamboni's columns; and the word *calorimotor* ought to be used when electricity becomes evanescent and caloric appears the sole product.

"It afterwards appeared quite natural," remarks Mr. W. B. Taylor (Note B, "Mem. of Jos. Henry," p. 376) "to distinguish these classes of effects by the old terms—'intensity' for electromotive force, and 'quantity' for calorimotive force. There is obviously a close analogy between these differences of condition and resultant, and the more strongly contrasted conditions of mechanical and chemical electricity; and indeed the whole may be said to lie in a continuous series, from the highest 'intensity' with minimum quantity, to the greatest 'quantity' with minimum intensity."

Two years later (1821), Dr. Hare constructed his *galvanic deflagrator*. It consists of two pairs of troughs, each 10 feet long, and containing 150 galvanic pairs, so arranged that the plates can all be simultaneously immersed into or relieved from the acid. Each pair turns on pivots made of iron, coated with brass or copper, and a communication is established between these and the voltaic series within by means of small strips of copper. The "Encyl. Britan." gives a full description of the construction and working of the apparatus, as do also the "Encycl. Met.," vol. iv. (Galv.), p. 176, Noad ("Manual," pp. 266, 267), Gmelin (Chemistry, vol. i., pp. 409, 410), and Silliman ("Journal of Sci. and Arts," vol. vii., p. 347). The first named publication says of Dr. Hare's *deflagrator*:

> A brilliant light, equal to that of the sun, was produced between charcoal points, and plumbago and charcoal were fused by Profs. Silliman and Griscom. By a series of 250, baryta was deflagrated, and a platina wire, three-sixteenths of an inch in thickness, "was made to flow like water." In the experiments with charcoal, the charcoal on the copper side had no appearance of fusion, but a crater-shaped cavity was formed within it, indicating that the charcoal was volatilized at this side and transferred to the other, where it was condensed and fused, the piece of charcoal at this pile being elongated considerably. This fused charcoal was four times denser than before fusion. In a letter from Prof. Silliman, which was transcribed in the *Sc. Am. Sup.*, for Sept. 21, 1878, he says: "Undoubtedly the earliest exhibitions of electric light from the voltaic battery were those made with the deflagrators of Dr. Hare by Prof. Silliman at New Haven in 1822, and subsequently on a magnificent scale at Boston in 1834, when an arc of over five inches diameter was produced by the simultaneous immersion of 900 large sized couples of Hare's deflagrator. But no means had then been devised for the regulation of the electric light to render it constant, and although the writer as early as 1842 used this light successfully to produce daguerreotypes, the progress of invention had yet to make further use of the discovery of science before electrical illumination was possible.

The description of Dr. Hare's electrical machine (before alluded to at Van Marum A. D. 1785), wherein the plate is mounted horizontally so as to show both negative and positive electricity, was published in London during 1823, and can be found in vol. lxii. of the *Phil. Mag.*, as well as at pages 538, 604, 605, vol. viii., of the 1855 "Encycl. Britan." In the last named article mention is made of the introduction of a band (illustrated Fig. 7, plate ccxxii.) which prevents the plate from being cracked, as it frequently is, through some hasty effort to put it in motion while it adheres to the cushions. It is also therein stated that, in order to offset the heavy expense attending the breakage of large cylinders and plates, Mr. Walkiers de St. Amand, of Brussels, among many others, made an apparatus of varnished silk 25 feet long and 5 feet wide, capable of giving sparks 15 inches long (see A. D. 1785) while Dr. Ingen-housz constructed machines with pasteboard discs 4 feet in diameter, soaked in copal or amber varnish dissolved in linseed oil, which gave sparks of one and even two feet in length.[4]

In the fifth volume, new series, of the *Amer. Phil. Trans.* will be found Dr. Hare's "Description of an Electrical Machine," with a plate 4 feet in diameter, so constructed as to be above the operator; also of a battery discharger employed therewith, and some observations on the causes of the diversity in the length of the sparks erroneously distinguished by the terms positive and negative. He is also the inventor of a single gold leaf electroscope of such great delicacy that it has, he says, enabled him to detect the electricity produced by one contact between a zinc and copper disc, each 6 inches in diameter.[5]

Dr. Hare invented several other electrical appliances, and he is likewise the author of numerous important memoirs which it would be impossible to detail in the narrow limits of this "Chronological History." They will, however, be found recorded in the publications named below:

A. D. 1819.——Gmelin (Leopold), the most distinguished member of the family of that name, publishes, at Frankfort, 1817-1819, the first edition of his celebrated "Handbuch d. theoret. Chemie," which embodies the whole extent of chemical science as it then existed and the fourth and last edition of which, under the author's supervision, appeared 1843-1845. This extensive work is well known to most of our readers, both in its original form and through the very able translation of it made by Mr. Henry Watts. In the report of the Council of the Chemical Society for 1854, it is said that "the greatest service which Gmelin rendered to science—a service in which he surpassed all his predecessors and all his contemporaries—consists in this: that he collected and arranged in order all the facts that have been discovered in connection with chemistry. His *Handbuch der Chemie* stands alone. Other writers on chemistry have indeed arranged large quantities of materials in systematic order, but for completeness and fidelity of collation and consecutiveness of arrangement, Gemelin's *Handbuch* is unrivalled."

Although many references have been made herein to Leopold Gmelin's treatment of such departments of science as directly appeal to the readers of this "Chronological History," it is well to make mention of some of the headings under which they are to be found. They are, for instance, "Electricity," "Electro-chemical Theories," "Electrolysis," "Technical Apparatus of Electricity," "Theory of Galvanism," "Galvanic Batteries," "Magnetic Condition of All Matter," etc., etc., the whole occupying pages 304 to 519, vol i., of the aforenamed English edition. The list of many of Leopold Gmelin's valuable contributions to science is given in the "Catalogue Sc. Papers Roy. Soc." besides which may be mentioned his "Übe. a ngebl. meteor masse" (Gilbert, *Annalen*, lxxiii., for 1823), and his "Versuch einer elektro chemisch. theorie" (Poggendorff's *Annalen der Physik und Chemie*, vol. xliv., for 1838, while at pages 547-550 of Mr. J. J. Griffin's able work, published in London during 1858, will be found the results obtained by Prof. G. Magnus and by Prof. Faraday with a summary of Gmelin's conclusions under the heading of "The Evidence of Electrolysis in Favor of the Radical Theory."

A Simple Method of Finding Cross Connections in a Coil.

It is an easy matter to find whether there is a cross connection between a coil and its core, but when the cross is between the wires themselves constituting the coils the usual method cannot be used. For such cases, as also for a number of others, a very ingenious and simple method is in use in the Thomson-Houston factory at Lynn, which is well worth the attention of those engaged in constructing apparatus containing coils in which cross connections may occur. It consists simply in placing the coil to be tested in the field of an alternating current coil and noticing whether or not parts of the coil become heated. It is evident that if there is a cross connection between the windings the turns included between these points will form a short circuited coil in which currents will be induced when placed in this alternating current field, which will cause that portion to become heated. This method, therefore, not only shows when there is a cross, but, if there is one, it to a certain extent locates it. In some cases the coil to be tested is placed in the field with its core and in other cases without. For simplicity nothing more could be desired.

Noiseless Gas Engine Exhausts.

Mr. P. Simon has been making a number of experiments with a view to deadening the objectionable noise made by the puffs of the exhaust pipe of a gas engine, and, after trying a number of different devices, he describes the following in a recent number of *L'Electricien*, which is such a simple device that it can be introduced by any one at a small expense.

A pipe split for a distance of about two metres is attached to the end of the exhaust, with the split end upward. Beginning at the lower end of the cut, which may best be made by a saw, dividing the pipe into two halves, the slotted opening is widened out towards the top until it has a width equal to the diameter of the pipe. The puff of the exhaust spreads out like a fan, and the discharge into the open air takes place gradually. The effect produced is said to be remarkable, but it depends somewhat on the flare of the tube.

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[1] "History of Induc. Sciences," 1859, vol. ii., p. 226.

[2] For Mr. Hansteen's scientific papers and for an account of additional magnetic results obtained by himself and others, consult the Eighth "Britannica," vols. i., p. 745; iv., p. 249; xiv., pp. 15, 23, 42 (experiment with Mr. Muschman), 50, 55, 57-64, *et seq.*, for Morlet and others; Thompson's "Outline of the Sciences," London, 1830, pp. 546-548; Whewell, "History of the Induc. Sci.," vol. ii., pp. 613, 615, also p. 219 for Yates and Hansteen; Johnson's new "Univer. Encycl.," 1878, vol. iii., pp. 231-234 for Morlet, etc.; Weld's "Hist of Roy. Soc.," vol. ii., p. 435; "Edinb. Jour. of Sci.," London, 1826, vols. i., pp. 87, 334; v., pp. 65-71, 218-222; "Report of Seventh Meeting British Association," London, 1838, vol. vi., pp. 76, 82; J. G. Steinhauser's articles published between 1803 and 1821; Harris' "Rudimentary Magnetism," London, 1852, part iii., pp. 38, 39, 111; *Phil. Mag.*, vol. lix., p. 248, and *Phil. Mag.* or *Annals*, vol. ii., page 334; "Zeitschr. f. pop. Mitth.," i., 33; Schweigger's *Journal*, 1813-1827; Poggendorff's *Annalen*, 1825-1855; "Académie Royale de Belgique" for 1853, 1855, 1865; C. Hansteen and C. Fearnley, "Die Univ.-Sternwarte. . . ." 1849; Hansteen, Lundh and Muschman, "Nyt. Mag. for Naturvid," 1823-1856. See likewise his biography in the "English Encycl.," Supplement, pp. 642, 643; "Catal. Roy. Soc. Sc. Pap.," vol. iii., pp. 167-172; "Annual Rec. Sc. Disc.," 1873, p. 683; 1875, p. 155; Knight's "Amer. Mech. Dict.," 1875, vol. ii., p 1,374, and Eighth "Britan.," vol. xiv., p. 49, regarding Hansteen's lines of no variation for 1787; Humboldt's "Cosmos," 1859, vol v., pp. 110-111, for the investigations of Hansteen, Sir Ed. Belcher and others, those of the last named being treated of at page 493 of the *Phil. Trans.* for 1832; Noad, "Manual," pages 529, 530, 534, 616, 617, etc.; Appleton's "New Am. Cycl.," vol. xi., p. 84.

[3] A full review of this work is to be found more particularly at p. 236, vol. liv., of the *Philosophical Magazine*; in the "Encycl. Metropol," vol. iv. (Galvanism), p. 222; in Ure's "Chemical Dictionary," Am. ed., article "Calorimotor;" at p. 137 of the *Phil. Trans.* for 1823; at pp. 409, 410, vol. i., of Gmelin's Chemistry, and at pp. 413-423, vol. i., of Silliman's *Am. Jour. of Sci.*, the last named being accompanied by a very fine illustration of the Calorimotor.

[4] *Phil. Trans.* for 1769, vol. lxix., p. 659. See also, for Walkiers de St. Amand, the entry at A. D. 1785, as well as Lichtenberg's *Magazin*, vol. iii., 1st, p. 118, for the last named year. To these might be added the machines made by Mundt, of silken strips (Gren's *Journal der Physik*, vol. vii., p. 319); by N. Rouland, "Descript. des mach. elec. à taffetas," Amsterdam, 1785; by Croissant and Thore, of papers by W. H. Barlow (*Phil. Mag.*, vol. xxxvii., p. 428), of gutta percha; as well as machines of rubber by Fabre and Kunneman, as shown at Th. Du Moncel's "Exposé des appl. de l'El.," second ed., p. 399, and third ed., 1872, vol. ii., pp. 78, 122, 265, besides the peculiarly constructed machines of Erdmann, Wolfram (Ferussac, "Bulletin des Sciences Tech." for 1824); of G. H. Seiferheld, "Beschreib . . . elektrische mach.," 1887; of F. E. Neuman, as modified by F. Zantedeschi ("Am. Sci. Lom.-Ven.," xii., p. 73), and of those described at p. 420, vol. ii., and at p. 4, vol. iii., of *Nicholson's Magazine*. Consult likewise pp. 335, 340, second Am. ed. of the "New Edinb. Encycl," 1817.

[5] Noad, "Manual," p. 29; Harris' "Rudim. Elect.," p. 50; Silliman's *Journal*, vol. xxxv.

[6] Poggendorff, vol. i., pp. 1,018, 1,019; "Cat. Sci. Papers of Roy. Soc.," vol. iii., pp. 177-182; Silliman's *Am. Jour. Sci. and Arts*, vols. ii., 312, 326, iii., 105, iv., 201, v., 94, vii., 103, 108, 351, viii., 99, 145, x., 67, xii., 36, xiii., 322, xv., 271, xxiv., 253, xxv., 136, xxxi., 275, xxxii., 272, 275-278, 283-285, xxxiii., 241, xxxv., 329, xxxvii., 269, 383, xxxviii., 1, 336, 339, xxxix., 108, xl. 48, 303, xli., 1, and xliii., 291; *Phil. Mag.*, vols. lvii., p. 284, lxii., pp. 3, 8, etc.; *Phil. Mag. or Annals*, vol. vi., pp. 114, 171; *Journal of the Franklin Institute*, 3d series, vol. xv., pp. 188, etc.; *Trans. of the Am. Phil Soc.*, N. S., vol. vi., p. 297 (for Hare and Allen) also pp. 339, 341, 343, and vol. vii. for 1841; "Mem. Jos. Henry," Washington, 1880, p. 82; Figuier, "Exp et Hist.," 1857, vol iv., pp. 391, 401, 402; Dr. Thomas Thomson, "Outline of the Sc.," London, 1830, pp. 515, 517; Appleton's "New Amer. Cycl.," vol. vii., p. 66; Appleton's "Dict of Machines. . . . ." 1861, pp. 432, 433; Dr. William Henry, "Elem. of Expr. Chem." London, 1823, vol. ii., p. 169, and Supplement, Chap., vii., p. 29; "Annual of Sc. Disc." for 1882, p. 99.

The Effects of Self-Induction and Distributed Static Capacity in a Conductor.

BY FREDERICK BEDELL AND ALBERT C. CREHORE.

The solution obtained by Sir Wm. Thomson for the variation of the current and the potential at different points in a conductor possessing static capacity is given by Mascart and Joubert, "L'Électricité et le Magnétisme," vol. i., § 233, and is treated at length by Mr. T. H. Blakesley in his book on "Alternating Currents." The object of the present communication is to give the solution of the case of a conductor possessing self-induction as well as distributed capacity, and to note the effects produced by the introduction of the self-induction.

The rate of change of the charge on an element of the cable is equal to the difference of currents flowing into and out from it; and so, writing q for the charge and i for current at any time, and x for the distance of any point from the origin—positive direction being that of the current flow—we have

$$\frac{dq}{dt} = -\frac{di}{dx}\,dx.$$

If e is the potential of an element, its charge is $q = C\,e\,dx$, where C denotes the capacity per unit length of the cable, and the first equation may be written

$$(1) \qquad C\frac{de}{dt} = -\frac{di}{dx}.$$

By Ohm's law the current in an element is equal to the total E. M. F. (the sum of the impressed and that of self-induction) divided by the resistance; and if R is the resistance per unit length and we assume the back E. M. F. of self-induction per unit length to be equal to the rate of change of the current multiplied by a constant L, we may write

$$(2) \qquad i = -\frac{\left(\frac{de}{dx}\,dx - L\frac{di}{dt}\,dx\right)}{R\,dx}.$$

In some cases this assumption may approximately represent the true effect of self-induction, and the results obtained from this particular assumption may show the nature of the effect of self-induction, even in cases where the assumption is not justifiable.

The differential equation for potential is obtained by eliminating i from (1) and (2) and is

$$\frac{d^2e}{dx^2} + LC\frac{d^2e}{dt^2} - RC\frac{de}{dt} = 0.$$

The current equation, obtained in the same way, is similar when i is written instead of e.

The general solution of these equations is

$$e = \sum_{h,k} hk\varepsilon^{\frac{R}{Ck^2+L}(t - Ckx)}$$

$$i = \sum_{h,k} h\varepsilon^{\frac{R}{Ck^2+L}(t - Ckx)}$$

where ε is the Napierian base, and h and k are constants to be determined.

If the impressed E. M. F. is harmonic, and at the origin $e = E \sin \omega t$, where ω denotes angular velocity, the solution for the potential at any point of the conductor at any time becomes

$$(3) \qquad e = \mathrm{E}\,\varepsilon^{\pm px} \sin(\omega t \pm \alpha x).$$

The solution for the current at any time across any section of the conductor is

$$(4) \quad i = \frac{-\mathrm{E}\sqrt{C\omega}}{\sqrt{Im.}}\varepsilon^{\pm px} \sin\left(\omega t \pm \alpha x + \tan^{-1}\frac{p}{\alpha}\right).$$

In these equations Im. denotes the impedance, $(R^2 + L^2\omega^2)^{1/2}$;

$$p = \sqrt{\frac{C\omega}{2}}\sqrt{Im. - L\omega}\,; \text{ and } \alpha = \sqrt{\frac{C\omega}{2}}\sqrt{Im. + L\omega}.$$

The solutions in equations (3) and (4) show that the potential and current are propagated in harmonic waves whose amplitudes decrease with the distance from the origin according to a logarithmic decrement. At any point of the conductor the potential and current vary as simple harmonic functions of the time with constant amplitudes which are different for every point of the conductor. The current wave is propagated in advance of the potential wave by an angle θ such that $\tan\theta = \frac{p}{\alpha}$. This phase difference diminishes with increase of frequency when there is self-induction, but becomes a constant angle of 45° when $L = 0$. The wave length is $\frac{2\pi}{\alpha}$ and the rate of propagation is $\frac{\omega}{\alpha}$. The wave length and rate of propagation each become less as the self-induction increases. The wave of higher frequency will have the shorter length and be propagated the faster. This difference in rate of propagation of waves of different frequencies is most marked when there is no self-induction.

The distance at which the amplitude decreases to $\frac{1}{\varepsilon}$th of its value is $\frac{1}{p} = \frac{\lambda}{2\pi\tan\theta}$; the time for the decreases is $\frac{1}{\omega\tan\theta}$. The rate of decay is most rapid when there is no self-induction. The waves of higher frequency decay more rapidly than those of lower frequency; when there is no self-induction this difference in the rate of decay is the greatest.

The difference in the rates of propagation and decay of waves of high and low frequency doubtless constitutes the limitations to the use of the telephone. As the several harmonic components of a complex tone advance along the conductor, they keep shifting their relative phases according to the difference in their rates of propagation, and also change their relative intensities according to the difference in their rates of decay, thus changing the resultant combination tone and materially altering its quality. These effects are always present in circuits containing distributed static capacity, but are not so marked when there is also self-induction.

Fuse Wires.*

BY C. P. FELDMANN.

If for any set of terminals the fusing current for a fuse wire of given length, diameter and substance be known, the current necessary to fuse a wire of any other length or diameter, but of the same substance, and clamped between the same terminals, may be found as the product of two constants—$c = af$. The constant a is the current necessary to fuse a wire of unit length and unit diameter, and has to be found by previously experimenting upon any wire whose constant f is known. f itself is a function of the length l and diameter d of the wire, and may be taken from the accompanying diagram, the use of which is best explained by an example:

To find the constant f for a wire whose length $l = 25$ millimetres, and whose diameter $d = 1.5$ millimetres, follow a vertical line nearly midways between 1.4 and 1.6 till it intersects with the horizontal line marked 25. Near the point of intersection you will find a stout line marked $f = 0.8$. This is the value wanted. For the alloy which I tested,† and for the small terminals (Fig. 2), I found $a = 31.6$ ($a^2 = 1{,}000$); for the large terminals (Fig. 3), I found $a = 36.8$ ($a^2 = 1{,}350$). The fusing current would have been, for the small terminals,

$$c = 31.6 \times 0.8 = 25.4 \text{ ampères},$$

and for the large terminals,

$$c = 36.8 \times 0.8 = 29.4 \text{ ampères}.$$

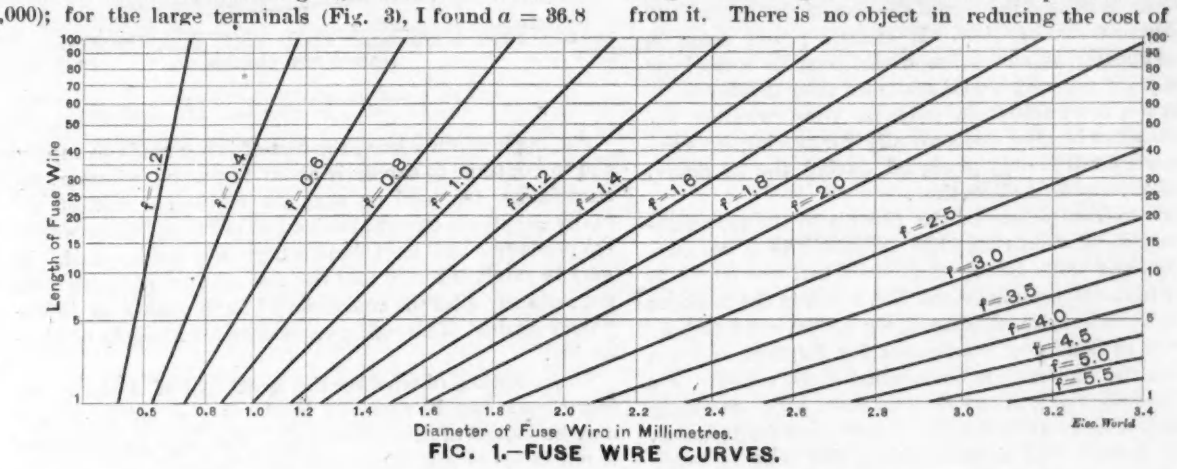
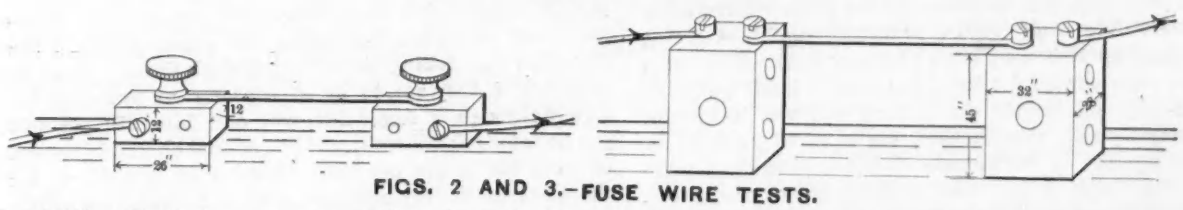


FIG. 1.—FUSE WIRE CURVES.



FIGS. 2 AND 3.—FUSE WIRE TESTS.

Of course a varies with the terminals, with the unit chosen to measure diameter and length, and with the substance of the fuse wire.

The diagram has been constructed by plotting as ordinates the $\sqrt[4]{e}$, and as abscissæ the $d^{3/2}$ or $\sqrt{d^3}$. If for any special purpose the values shown in the figure should not be found suitable, the units of length and diameter may be changed so as to fit the scale of the diagram. *But it must not be forgotten that the constant a has to be changed, too, in a suitable manner that is, it has to be determined by another experiment and for the new units chosen.*

Conditions Under Which Trees Are Subject to Destruction by Lightning.

Mr. D. Jonesco has compiled statistics concerning trees which are struck by lightning, and arrives at the following interesting conclusions. It has been supposed for a long time that certain kinds of trees are particularly subject to destruction by lightning, while others are quite free from danger. Among the first is the oak, and among the latter the laurel. An investigation of this statement led that writer to the following conclusions:

"At very high potential electrical discharges all kinds of trees may be subject to destruction from lightning. Trees containing oils are less subject to be struck, those containing very much oil being protected the most. Lightning appears to prefer those trees which contain starch and also those which contain oil to a slight degree only, in summer. The quantity of water contained in the trees has no effect on their liability to being struck. Dead limbs of trees, of those containing starch as well as of those containing oil are particularly subject to being struck. Cambium, bark and leaves do not alter the conductivity of trees. The nature of the soil has no connection with the frequency of destruction of the trees by lightning."

* From *The Electrician* (London).
† The *Electrician* (London), vol. xxix., p. 87.

The Cost of Electric Supply.—III.*

BY DR. JOHN HOPKINSON, F. R. S.

The charge for a service rendered should bear some relation to the cost of rendering it. If it is a matter of open competition the matter will settle itself, for no one will for long be able to supply some customers at a loss, and recoup himself by exorbitant profits from others. If the matter be a case, more or less, of monopoly, the adjustment is less certain; thus, the Post Office charges ½d. postage for a printed circular, and 1d. for a written letter, the two costing the Post Office exactly the same. What a boon to the public it would be if the Post Office would charge more for printed trade circulars, which in nine cases out of ten are a nuisance to those who receive them. The supply of electricity is not quite a monopoly; companies compete with each other, and there is always the competition with other methods of illumination, such as gas and paraffine. It is clearly to the advantage of the undertaker to secure all those customers whom it pays best to supply, and as far as may be, to compel those who are unrenumerative to adopt these other methods. The ideal method of charge, then, is a fixed charge per quarter proportioned to the greatest rate of supply the consumer will ever take, and a charge by meter for the actual consumption. Such a method I urged in 1883, and obtained the introduction into certain provisional orders of a clause sanctioning "a charge which is calculated partly by the quantity of energy contained in the supply and partly by a yearly or other rental depending upon the maximum strength of the current required to be supplied." In fixing the rates of fixed charges it must not be forgotten that it is improbable that all consumers will demand the maximum supply at the same moment, and consequently the fixed charge named might be reduced or some profit be obtained from it. There is no object in reducing the cost of electricity for lighting in the case of any customer much below the cost of equivalent lighting by gas, unless there are competitors in the field willing to do it, hence the current charge proportioned to the power supplied may safely be increased. In certain recent cases in which I am acting as engineer, the Board of Trade has sanctioned on my application, "for each unit per hour in the maximum power demanded, a charge not exceeding £3 per quarter, and in addition for each unit supplied a charge not exceeding two pence." It is sometimes said as an objection to this method of charge the public will object to pay a fixed charge whether they make use of their lights or not, and that, in fact, they will not pay it. The best answer that can be made is to give every one the choice of being charged the maximum simple rate provided by the order, or by the compound rate as they prefer. What is wanted is not so much an increased charge for those consumers whose lights are used for a short time, as such a special reduced charge for those whose lights are used long as will induce them to use the supply.

It is instructive to compare the cost to different classes of consumers of electricity and gas for lighting with 16-candle gas. Flat flame burners must be large and of first-rate quality to give more than two candles per cubic foot of gas per hour; the large majority of burners give much less than this even at their best, and as a rule the pressure of the gas is not regulated, and much gas is wasted as far as the production of light is concerned. Incandescent lamps give about one quarter of a candle per watt; hence a Board of Trade unit is equivalent to 125 cubic feet of gas. Thus we readily arrive at the following comparative table, the charge being at the rates recently sanctioned by the Board of Trade:

Hours of use per annum.	Load factor.	Price of gas at which cost of lighting by electricity and 16 candle gas are equal.
480	5.5	5s. 4d.
960	10.9	3s. 4d.
1,440	16.4	2s. 8d.
1,920	21.9	2s. 4d.
2,880	32.9	2s. 0d
3,840	43.8	1s. 10d.
7,680	87.6	1s. 7d.

* Presidential address before the Junior Engineering Society (London). For the first section of this paper see THE ELECTRICAL WORLD, Dec. 3, 1892.

In the accompanying curves are shown the cost of production and the charge per unit at the compound and simple rate. The ordinates represent pence and the abscissæ the number of hours per annum the supply is used.

It is obvious that those whose use is long will find the electric light economical to themselves, and that it will be profitable to the undertaker. With a cheap light which is free from the products of combustion there will be extensions for the hours of use. Shops may find it worth while to continue the light after closing, as an advertisement.

We have so far assumed that the supply of electricity is carried on without the aid of accumulators. Let us first compare the cost of an electric accumulator with the cost of a gas holder containing the same possibility of producing light. A gas holder is at present being put up in Manchester to hold seven million cubic feet of gas, and is to cost complete with its tank £60,000. With 16-candle gas seven million cubic feet are equivalent to 56,000 Board of Trade units. Accumulators capable of storing a ten hours' supply cost about £50 per unit. The equivalent accumulator will therefore cost about £280,000. But this is not all: the gas holder is comparatively permanent, the accumulators require frequent renewals and repairs; the gas holder gives back all the energy put into it. the accumulators waste at least 20 per cent.; the gas holder may be emptied as fast as you please, the accumulators not faster than a certain rate without diminishing their capacity. Taking all into consideration, the cost of storing energy by the aid of accumulators and storing it in a gas holder are quantities of a different order of magnitude. If no gas holders were used, and all the gas had to be made just as it was wanted, its cost for lighting would be several fold what it now is, even if gas producers could be found capable of instantly varying the supply as the demand varies. The gas-producing plant would have to be enormously increased; so would the size of the mains, and so would the wages of labor. If electric power could be stored as cheaply as gas, there would soon be little hope that the gas companies would maintain their dividends.

Let us see, from a financial point of view, whether accumulators can be used economically for storing up electrical power continuously produced during the 24 hours, and used rapidly for a short time.

Assume that the whole of the plant with the accumulators is capable of supplying 40,000 lights for 10 hours continuously, and that during that time half the power is supplied from the accumulators. Ten hours in the 24 hours is not an unreasonable allowance, for we have melancholy experience in London of continuous fog for days, and this would tax the plant we are considering to the utmost. We are to be ready, then, at any time on short notice to supply 40,000 lights, and to continue to supply them for 10 hours. Compare the cost first of maintaining this state of readiness with the accumulators and with a plant without accumulators. We shall require a battery capable of giving 1,250 units for 10 hours; such a battery costs not less than £50 per unit, or in all £62,500. To maintain it will cost from 10 to 15 per cent. on the cost; there will also be interest on the outlay and amortization, say in all 20 per cent., or £12,500 a year. If we assume that the batteries are distributed at the various points of the system of conductors, we may also assume that the charges for and and buildings will be much the same as for the plant without accumulators. The boilers, engines and dynamos will be just one-half. The switchboard and instruments will be much the same. But the conductors will be reduced, smaller or shorter feeders being necessary, probably £40,000 will go as far with accumulators as £50,000 without. The coal bill may be dispensed with entirely, as we may assume that steam could always be got up during the time in which the demand increases from nothing to one-half of the maximum, and that, therefore, all the coal burned can be assumed to be burned for producing current. That is to say, we assume the quantity of coal burned is proportional to the quantity of electric energy, and that, therefore, when no electricity is actually used, no coal will be burned. The wages may be reduced, for we have only to be ready to run half the plant, and a small wage will suffice for attendance on the accumulators. The wages of linemen and the like will remain the same. Assume the total wages to be £3,500 instead £5,000, the account will then stand thus:

Land	£1,000
Buildings	1,500
Rates	500
Accumulators	12,500
Boilers	1,050
Engines	1,080
Dynamos	675
Switchboard	300
Conductors	6,000
Wages	3,500
	£28,105

practically the same result as we obtained before.

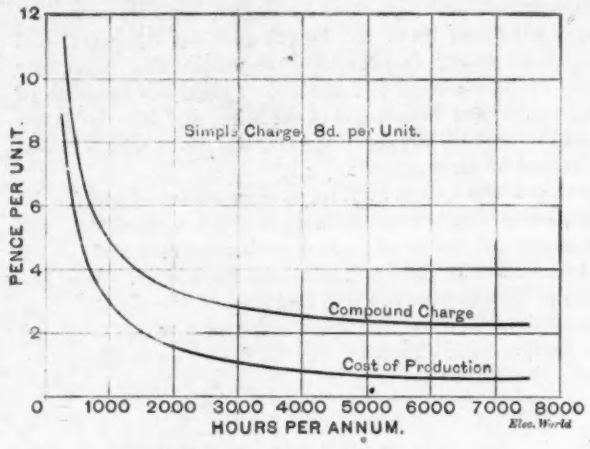
Now consider another hypothetical case, which, of course, can never occur in practice. We are to supply 40,000 lamps for ten hours every day with the plant just described, charging the accumulators during 12½ of the 14 hours during which the light is not required, 12½ hours' charging giving ten hours' discharge of the same energy. The coal would cost the half of £30,000 if the machinery had to run the whole of the 24 hours. It has to run 22½ hours, but the boilers have to be kept warm the whole time, hence the coal will cost the half of £6,000 for keeping the boilers warm, and twenty-two and one-third twenty-fourths of the half of £24,000 for generating steam. The wages may fairly be taken as £4,750, and the account will stand:

Land	£1,000
Buildings	1,500
Rates	500
Accumulators	12,500
Boilers	1,050
Engines	1,080
Dynamos	675
Switchboard	300
Conductors	6,000
Wages	4,750
Coal	14,250
Stores	1,425
	£43,200

The cost of supply for the same ten hours without accumulators would be as follows:

Land	£1,000
Buildings	1,500
Rates	500
Boilers	2,100
Switchboard and conductors	7,800
Engines	2,760
Dynamos	1,725
Coal	16,000
Stores	1,600
Wages	6,000
	£40,985

a cost of about 11 per cent. less than where accumulators are used.



The Cost of Electric Supply.

Putting it another way, the cost of being ready to supply and to continue to supply is about the same whether accumulators are used or not; the additional cost of actually supplying current is about 40 per cent. more where accumulators are used than where they are not used. It may be safely inferred that the use of accumulators does not seriously alter the conclusions I have drawn as to the proper method of charging consumers for a supply of electricity.

The question of whether the great cost of a supply for short hours can be removed by the use of accumulators may be looked at in another way. Will it pay a consumer to put in his own accumulators and charge them from the station supply? We may reasonably suppose the undertaker will remit the fixed charge in consideration of the consumer only taking his current at slack times. His accumulators, if they are to be of capacity to maintain his supply through a foggy day, will cost him £50 per unit per hour (or per kilowatt), and the annual charge in respect of them will be £10 per year, which, if we add a rent for the space the battery occupies, gives us a charge not differing materially from the fixed charge made or suitable to be made by the undertaker. But in order to obtain 2d. worth of electricity he must purchase 2½d. worth for charging his battery.

A word or two more about the use of accumulators. These have certainly improved, and they will continue to improve. They will become more durable and more economical of power in working, and their first cost will become less. An inspection of my tables of cost shows that a very little improvement would render them valuable even in very large stations for the mere purpose of diminishing the machinery required, by storing the energy developed at slack times to be used in busy times. The certainty of improvements in accumulators, and the possibility that the improvement may be considerable, is a strong argument for the use of the direct current wherever it is not precluded by the distance of transmission being too great.

It will be noted that I have assumed a very large station. Accumulators have another use which greatly increases their advantage in smaller stations. There are many hours in the twenty-four when it is absolutely certain that the demand will be small. If accumulators are used the attendance of the staff may be dispensed with during those hours, and a considerable sum in wages will be saved. The proportion of wages to the whole of the charges is much greater in small stations than in large. In most small stations giving continuous supply, accumulators ought to be used notwithstanding their expenses and defects, and I believe the day is not far distant when they ought to be used in connection with most large stations also.

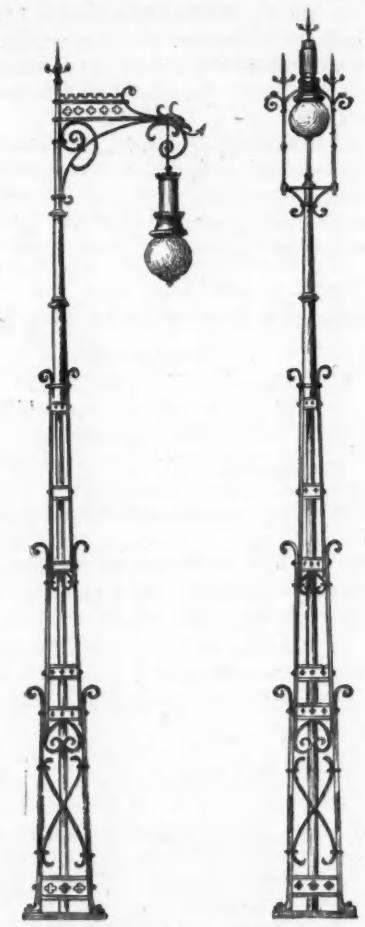
If, instead of a continuous current, an alternating current with transformers is used, the modification in the account will be that the cost of conductors will be diminished, but the cost of transformers will have to be added. If the distances are small the increased cost of transformers will exceed the saving in the conductors; if the distances are considerable the cost of transformers will be less than the saving of conductors. In both cases the general character of the result will be the same as before; the cost of being prepared to give a supply will be considerable, and the cost of actually giving the supply will be much smaller than is generally supposed. Indeed, with the alternating current this peculiarity will be even more marked, for the machinery has not only to be kept in motion, however small the consumption may be, but a certain current must be maintained in every transformer. With the best transformers this current may only have an energy 1½ per cent. of the energy of the current when the transformer is fully loaded. This would increase the coal bill in the case considered by about £500 per year whether the supply was used or not.

It is possible, indeed probable, that some of my assumed figures may be shown to be too high or too low for the generality of cases. It is of no moment; let each one take any figures he pleases within reason; let him assume that the supply of electricity is made by any system he pleases; he will arrive at a result broadly similar to mine. To be ready to supply a customer with electricity at any moment he wants it will cost those giving the supply not much less than £1 per annum for every kilowatt, that is for every unit per hour, which the customer can take if he wishes; and afterward to actually give the supply will not cost very much more than ½d. per unit. This is the point I have been laboring to impress, for I take it it is essential to the commercial success of electric supply. It is hopeless for electricity to compete with gas in this country all along the line if price is the only consideration. But with selected customers electricity is cheaper than gas. Surely it is to the interest of those who supply electricity to secure such customers by charging them a rate having some sort of relation to the cost of supplying them.

(Concluded.)

Artistic Lamp Posts.

In the early days of electric street lighting any sort of pole was thought sufficient for the suspension of the lamps provided it was of the requisite height and moderately straight. Not only were the poles themselves unnecessarily heavy but they were disfigured by a series of pegs to enable the lamp trimmer to reach the carbons. Gradually more care was taken in their selection, they were treated to a coat of paint, and, finally, in the large cities, replaced by iron poles, which although not things of beauty were a decided step in advance. Very recently, however, an effort has been made both in this country and abroad to secure arc lamp posts of a somewhat more artistic design, and in the accompanying illustration is seen the latest type which has been set up in the main thoroughfares of London. It will be seen that this pole is reasonably light, and of quite graceful outlines, being a distinct advance upon the most of those which are now in common use.



Poles for Street Lights.

An Electric Mine Railroad.

The electric railroad which was constructed some time ago by Messrs. Ganz & Co., of Budapest, in the coal mine of the North Hungarian United Coal Mining and Manufacturing Company at Miszerfa-Csibaj, has proved a great success. The road is about 1¼ miles long, has a gauge of 24.8 in., and has a varying grade of from 2 to 6½ per cent. The cars are run at a speed of about 10 miles an hour. A small electric locomotive, weighing about 4,400 pounds, and rated at 6 h. p., is used to haul the cars, and is confined to 42 inches width and 56 inches in height, so as to readily pass through the mine headings. A 330-volt electric current is used, the generator being at the foot of the main shaft, and driven by a 40-h. p. steam engine. This generator plant was put in specially with the view to further extension of the electric haulage system.

Experimental Researches on Alternate Current Transformers.*

BY DR. J. A. FLEMING.

1. One of the objects of this investigation was to arrive at some definite certainty on the best practical method of quickly testing transformers in actual use and *in situ*. The particular methods employed by Dr. Hopkinson and Prof. Ayrton and Dr. Sumpner involve the possession of two transformers of equal size. These methods are in principle an extension to transformers of Dr. Hopkinson's methods of measuring the efficiency of dynamos, and they are based upon the obviously right method of measuring directly the quantity we desire to know—viz., the power lost in the transformer—rather than measuring it as the difference of two very much larger quantities—viz., the power going in and the power coming out. These methods, as well as others which depend upon the graphic description of the current and electromotive force curves, have the disadvantage that it is often impossible to apply them, because only one transformer is at disposal, or because the observer has not access to the dynamo, and accordingly the first matter which engaged attention was an examination of the degree of accuracy to be reached by the simple direct methods which can be applied under such conditions as can generally be obtained in practice and when using the commercial instruments to be found or obtained in every testing laboratory.

I.—METHODS OF MEASUREMENT EMPLOYED.

2. In order that an opinion may be formed as to the confidence to be placed in the quantitative experiments described, it may be well to give, in the first place, some details as to the methods adopted for measuring the potential differences, currents, etc., and processes of calibrating the instruments used. These instruments were then employed in measuring the power taken up by transformers with open, or loaded, secondary circuits. As single transformers only of each type were at disposal, we entered on a preliminary investigation on the degree of accuracy to be obtained with using such methods as the three voltmeter, the three ammeter, and the two circuit electro-dynamometer wattmeter of various constructions.

In order to avoid tedious repetitions, it may be observed once for all that when mention is made of "the current," or "the potential difference" of such and such an amount the *effective* value is meant, or the square root of the mean of the squares of the equi-distant instantaneous values, unless otherwise stated. The letters P. D. are used as an abbreviation for *effective* potential difference.

Mr. Swinburne placed at my disposal four of his electrostatic torsional voltmeters, and also two of his dynamometer wattmeters, and there were also at hand a sufficient supply of Kelvin current balances and electrostatic voltmeters and other appliances for the calibration of the above instruments. Since these Swinburne electrostatic voltmeters proved useful in much of the work, it may be advantageous to point out their good and bad points, and also to say how they were improved, calibrated, and used in these experiments. As they have been sufficiently described by their inventor, suffice it to say that they consist of two tiers of semi cylindrical metal boxes, *B*, Fig. 1, insulated from each other. A vertical metallic axis carries two semi-circular aluminium "needles," set at different levels, so that one is enclosed in the upper pair of boxes and the other in the lower. This needle is strung at the top and bottom by a round phosphor-bronze wire 0.003 or 0.004 inch diameter, and the top end of the upper wire is held by a torsion head, *T*, the indicating needle of which moves over a graduated scale. In most of the experiments these voltmeters were used as idiostatic voltmeters, and the "needle" and one pair of semi-cylinders formed one terminal of the instrument, and the other pair of semi-cylindrical boxes the other terminal. When a definite potential difference is made between the two terminals, the needle is displaced from its normal position, and the semi-circular needles attracted into the semi-cylindrical enclosing boxes, which are at a different potential. The upper torsion head is then turned until the needle comes back to its initial position. This is accurately determined by affixing a mirror to the axis of the electrometer needle. The image of the filament of an incandescent lamp is then thrown on the mirror by a lens, and, after reflection, received on a paper scale about one metre away. By a simple reference point on this scale it is easy to bring back the line of light accurately to its original position. In first working with these instruments we were greatly troubled by electrical discharges passing across from the "needle" to the cylinders and destroying the suspending wire by the resulting current. The simple remedy for this was found in enclosing each semi-circular aluminium disc of the "needle" between two thin sheets of mica which projected slightly over the edge of the sheet of metal. The instrumental utility of the voltmeter was not at all impaired, while at the same time discharges between the needle and enclosing boxes were prevented, and thereby much labor saved. The sensitiveness of the voltmeter was such that when used to read an alternating potential of 2,400 volts, a difference of three or four volts was easily detected, and with sufficiently steady potential there was no difficulty in taking the reading of about this number of volts to one-quarter per cent. accuracy. The great defect of the instrument, as it stands, is the large amount of inertia of the needle, and this, in the absence of any effective damping arrangement, creates a great waste of time in getting readings.

The instruments were provided with an electro-magnet intended to be used for creating a magnetic damping field. This, however, proved to be ineffective. A far better plan when such a heavy needle is employed is to damp out the oscillations by a suitable mica vane dipping in oil or water.

3. In calibrating these voltmeters, the first step was to prepare a standard inductionless resistance capable of carrying, without sensible heating, a current of at least a quarter of an ampère, and which could be subjected to an alternating pressure of 2,000 to 3,000 volts without risk of short circuiting. This was formed by winding double silk-covered platinoid wire (No. 36 B. W. G.) round a wooden frame. The wire windings were each kept separate by being wound in serrations, or teeth, cut in the edge of varnished slate slips fixed at the top and bottom of the frame. The frames were about 37 inches long and 14 inches wide, and the wire made 56 turns round the frame, each turn of wire being separated by about a quarter of

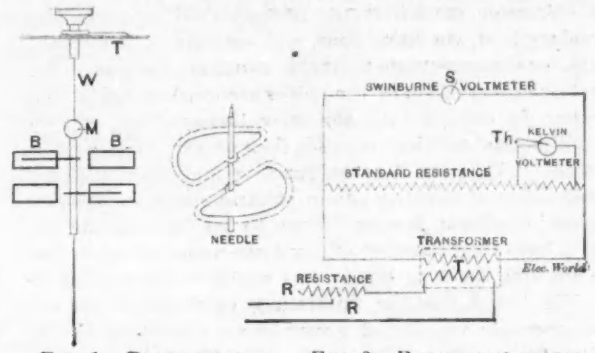


FIG. 1.—DIAGRAM OF SWINBURNE VOLTMETER.

FIG. 2.—PLAN OF CONNECTIONS USED IN CALIBRATING SWINBURNE VOLTMETERS.

an inch from its neighbors. The length of wire on each frame was about 126 yards, measuring some 1,600 ohms. Six of these frames were provided, giving us, therefore, about 9,600 ohms resistance in the form of a wire perfectly insulated in every part and between every turn. This wire was capable of carrying about one-quarter of an ampère without any very sensible heating, and about three-quarters of an ampère without exceeding safe limits. Every part of the wire was accessible, and exposed to the cooling action of the air. The six frames were fastened up to the ceiling of the laboratory and arranged so that the direction of the wire windings was alternately right and left. The resistance of all these coils was measured when at 15° C., and found to be 9,543.0 ohms.

On coil 1 two terminals were placed, one at a distance of 394.7 ohms from the end, and one at a distance of 1,212.5 ohms from the end. By taking leading wires from these points it was possible to divide the whole resistance of 9,543 ohms into two sections, having in one case resistances in the ratio of 23.175 to 1, and in the other case a ratio of 6.87 to 1. This divided resistance was a practically non-inductive resistance of about 10,000 ohms, divisible into two sections in the ratio of 23 to 1 or 7 to 1. If a measured alternating pressure of 2,400 volts was applied to the ends of this resistance, the wire came to a steady temperature of about

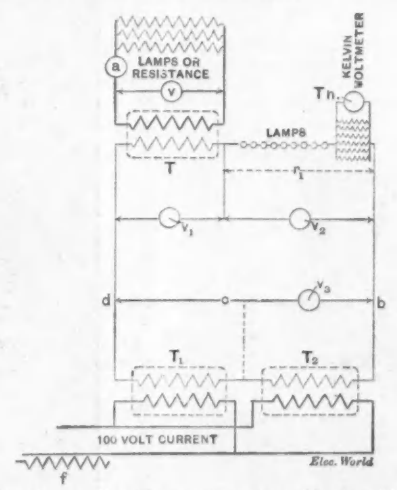


FIG. 3.—PLAN OF CONNECTIONS FOR THREE VOLTMETER METHOD.

20° C. to 25° C. above the atmospheric temperature (15° C.), as nearly as could be judged by a thermometer. Taking the coefficient of change of resistance with temperature for platinoid as equal to 0.021 per cent. per degree, it will be found that at 40° C. the whole coil would have a resistance of 9,591 ohms, and hence, if truly non-inductive, the current through the coil would then have a value of 2,400 ÷ 9,591 = 0.250 ampère. The actual current, carefully measured by a Kelvin deciampère balance, was found to be exactly 0.250 ampère, thus showing that the resistance was, for all practical purposes, non-inductive.

In all subsequent experiments it was therefore taken that when an alternating pressure of 2,400 volts was applied to this resistance, it passed a current of 0.25 ampère and absorbed 600 watts. This resistance will be hereafter called the "No. 1" resistance for reference. By the aid of this divided resistance the Swinburne voltmeters were easily calibrated.

A "24 to 1" transformer, *T*, Fig. 2, was connected to 100-volt mains through a rheostat *R*, so as to raise the pressure and enable it to be regulated within limits. The above standard divided resistance was placed across the high tension terminals, and a Kelvin multicellular electrostatic voltmeter, *Th*, and a Swinburne electrostatic voltmeter, *S*, connected respectively to the small section and to the whole length of the resistance, as shown in Fig. 2.

By taking the readings of the Kelvin electrostatic voltmeter corresponding to various pressures and multiplying these readings by 24.175 we obtained values for the P. D. at the terminals of the Swinburne voltmeter, and hence the true values of the instrumental readings of the last-named instrument. For each Swinburne voltmeter a calibration curve was then prepared in which the horizontal abscissæ were the torsion-head readings, and the corresponding ordinates the true P. D. in volts at the terminals of the instruments. This curve was found to be a very exact parabola. Having proved this to be the case by many experiments for each of the four Swinburne voltmeters, we subsequently adopted for each voltmeter an instrumental constant, the product of which by the square root of the torsion-head reading gave the terminal P. D. on the instrument. These constants were determined for each instrument at the beginning and end of every set of experiments.

In addition to the above standard resistance, another set of six similar coils was provided, each coil of which consisted of No. 32 B. W. G. platinoid wire wound in the same open manner on a frame. Each of these coils had a resistance of about 500 ohms, and each coil could carry comfortably, without any very sensible heating, about half an ampère. These last six coils were specially intended to be used for current measurement, as follows: The coils were arranged either two, four or all six in parallel, and the current to be measured passed through them. The P. D. at the ends of the compound resistance was measured by a Kelvin electrostatic voltmeter. The arrangement was standardized as an ampère meter by passing known currents through the coils, measured by a Kelvin ampère balance, and then observing the P. D. at the ends of the compound resistance. In this way the true resistance of the coils grouped in various ways when carrying currents was found, and at any subsequent time the mere reading of the P. D. at the ends of the resistance gave the current passing through the coils. The reason for employing an electrostatic voltmeter and resistance in this way to measure current was that we thereby obtained an inspectional ampère meter much more convenient in many experiments than an ampère balance or dynamometer. It will be seen, therefore, that all the measurements were ultimately referred to one Kelvin electrostatic voltmeter and one Kelvin deciampère balance. These instruments were found to agree with one another. Any other instruments, such as Siemens dynamometers or an Ayrton and Perry twisted strip ammeter, sometimes used, were standardized and referred to the above mentioned Kelvin balance, which was one specially constructed for alternating current measurement.

This last mentioned set of six resistance coils will be hereafter spoken of as the "No. 2" set. We frequently employed the No. 1 and No. 2 resistances in series, giving us a practically non-inductive resistance of about 12,000 ohms. The No. 1 resistance was also employed as an absorber of power. For if the six coils, each of about 1,600 ohms, were arranged three in parallel and two in series, we obtained an effective resistance of about 1,100 ohms, and this, when placed across a 2,400-volt circuit, passed a total current of rather more than 2 ampères, and absorbed about 5,000 watts. We found it very convenient to employ this resistance in this manner as a standard non-inductive power absorber for obtaining the constant of various forms of wattmeters. Although using the No. 1 resistance in this way to absorb nearly 7 h. p., the current passing in each single wire was not more than two-thirds of an ampère, or well within the safe limits.

II.—EXPERIMENTS WITH THE THREE VOLTMETER METHOD OF MEASURING ALTERNATING CURRENT POWER.

5. Having the necessary instruments all calibrated and compared, a series of experiments was made with three or four of the Swinburne voltmeters, using them in accordance with the well-known method for measuring the power taken up in transformers on open secondary circuit.

Two 5 h. p. transformers were arranged with low tension coils in parallel on a 100-volt circuit, and high tension coils (2,400 volts) in series, as shown in Fig. 3. The current through the low pressure coils could be varied by a rheostat, *f*, and hence the P. D. at the high tension terminals of the transformers given any desired value from 2,400 volts downward.

In the diagram (Fig. 3) *T* is a transformer in which the power taken up is to be measured; T_1 and T_2 are the 5-h. p. pressure transformers just mentioned. The torsion voltmeters, V_1, V_2, V_3, were arranged as shown; V_1 being across the terminals of the transformer to be measured; V_1 being across a non-inductive resistance, r_1, put in series with the primary coil of the transformer *T*, and V_2 used to measure the total P. D. between the outside terminals of the two pressure producing transformers, T_1 and T_2. Since T_1 and T_2 were identical transformers, it was generally quite sufficient to measure the P. D. between the terminals of one transformer, T_1 or T_2, and to take double this P. D. as the value of V_3, except in cases where the total P. D. exceeded the limits of safety for one voltmeter, and then two voltmeters were used, one across the terminals of each transformer. Under these circumstances, as is well known, the

*Abstract of a paper read before the Institution of Electrical Engineers (London).

power, W, taken up in the transformer, T, under test is by the formula,

$$W = \frac{1}{2\,r_1}\left\{ V_3^2 - V_2^2 - V_1^2 \right\}.$$

In applying this method we had several difficulties to overcome before we could get any satisfactory results. In the first place, the transformer to be tested must have the potential difference, V_1, between its primary terminals always exactly maintained at the normal pressure, which, in all our experiments, was 2,400 volts. In the second place, the potential difference V_2^2 must always be made as nearly equal to V_1 as possible, in order to obtain the condition of greatest probable accuracy of measurement—that is, to obtain the condition in which given small percentages of error in the several voltmeter readings produce the minimum percentage error in the calculated power. In the third place, the resistance in r_1 must be practically non-inductive, and must be capable of being varied in amount as required to fulfill the condition of making V_2 equal to V_1. We met these conditions in the following manner: In cases in which the transformer T was not loaded on the secondary circuit, and in which, therefore, the current flowing through its primary circuit was not greater than could be comfortably carried by the No. 1 10,000-ohm standard resistance, we employed that resistance, arranging all six coils in series. In series with this we placed some or all of the coils of the second resistance, arranged in series or in parallel, and we placed a Kelvin voltmeter to read the fall in volts down one of these last coils. In other cases, when the transformer T was loaded up on its secondary circuit, and when, therefore a larger current was flowing through its primary circuit, we employed a series of 24 50-c. p. 100-volt incandescent lamps, or several series of lamps in parallel, adjusted as required to obtain the requisite resistance. When these lamp resistances were used, the second (No. 2) set of resistance coils, arranged with 2, 4 or 6 in parallel, as necessary, were placed in series with the lamps. By measuring the fall in volts down this known wire resistance by a Kelvin electrostatic voltmeter, th, and the fall in volts over the lamps and resistance taken together by means of one of the Swinburne voltmeters, V_2, we were able to determine at any instant the value in ohms of this non-inductive resistance from the reading of the two electrostatic voltmeters and the known value of the wire resistance across the terminals of the Kelvin voltmeter.

The process of getting a reading was this: The resistance r_1 was varied suitably until the value of the P. D. V_1 was as nearly as possible equal to the value of the P. D. V_2. The feeding transformers T_1 and T_2 had a rheostat in their common low pressure circuit, which was then varied until the P. D. V_1 came to the value 2,400 volts, and it was constantly maintained at that value. The reading of the other two voltmeters was then noted, as well as that of the Kelvin voltmeter th. If we call A the ampère value of the current flowing through the primary coil of the transformer T, and, therefore, also that through the resistance r_1, it is obvious that the value of r_1 is determined at once from the value of the P. D. V_2 and the value of the current A. A is, of course, known by the previous calibration of the Kelvin voltmeter and associated resistance as a non-inductive ampère meter. Hence, if V_1 is constantly maintained at the value 2,400 volts, we see that the power W, taken up in the transformer, is given by the formula,

$$W = \frac{A}{2V_2}\left\{ V_2^2 - (2{,}400)^2 - V_2^2 \right\}.$$

If it had been possible to make V_2 also always exactly 2,400 volts, the formula would have been still more simplified.

It will be observed that we used a row or rows of 24 or less 50-c. p. incandescent lamps as our non-inductive resistance, and determined the actual resistance at any instant by observing the terminal P. D. of the row of lamps, and the current flowing through them as measured by the fall in volts down a small known non-inductive resistance placed in series with them. We found this to be a better method than using any form of ammeter in series with the lamps—first, because we were more sure of not introducing prejudicial inductance into the lamp circuit; and, secondly, because we found we could obtain greater accuracy in the measurement of the current than by any other ammeter suitable for the purpose. The justification for using such a row of lamps as a practically non-inductive resistance is that if an incandescent lamp is placed in series with a dynamometer suitable for measuring both alternating and continuous currents, and if the terminal P. D. on the lamp is adjusted, say, to 100 volts as measured by an electrostatic voltmeter, no sensible difference can be found in the current as measured by the dynamometer, whether that current is alternating or continuous.

It will be seen that when the transformer under test is loaded on its secondary circuit, in addition to the ammeter and voltmeter measurements necessary to estimate the secondary load, we have four, and sometimes five, other voltmeter measurements to make simultaneously in order to get one observation of the power absorbed in the transformer. In dealing with the mere theory of an experimental method nothing is easier than to say "Let V be a constant P. D."; but in actual practice and when working off the mains of existing public electric supply companies this ideal condition is very difficult to realize, and the observers have their patience strained often almost up to the safe working limits to obtain any results worth having at all. We found that the multiplicity of readings to take simultaneously constituted a very great drawback to the utility of this voltmeter method. Having the apparatus, however, set up, and the instruments all calibrated, the method was applied to measure the power absorbed in a number of transformers with open secondary circuits, and in one or two cases the power taken up in the transformer corresponding to various secondary loads was also taken.

(To be continued.)

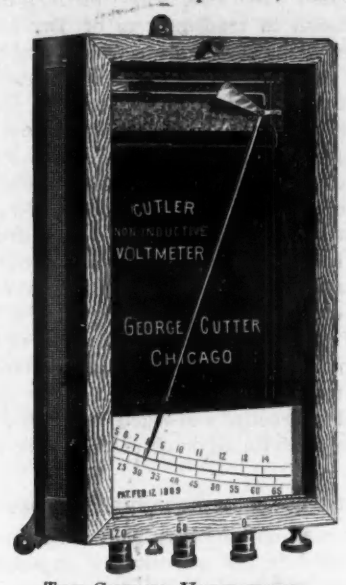
The Buffalo College of Commerce and Practical School of Electricity.

This institution will open on Jan. 1 with from 40 to 50 scholars, consisting of mechanics, engineers and motor men, who are desirous of some practical knowledge of electricity and electrical machinery, which it is the aim of this school to furnish. A large workshop and laboratory has been fitted up. This contains a 10 h. p. Case engine, Mather, Edison, Jenney, Crocker-Wheeler, and other machines. A large electrical library is a useful adjunct. The electrical course is in charge of Mr. Frank C. Perkins, with Mr. Robert Bussey as assistant.

The Cutler Non-Inductive Voltmeter.

In The Electrical World of Nov. 19, 1892, the hot wire ammeter devised by Mr. H. H. Cutler for use on either direct or alternating currents was illustrated and described. The same principles underlie the non-inductive voltmeter which is shown in our cut and which is being used with good results at a number of places. The two expansion wires, one of which does the measuring while the other compensates for changes in the temperature of the room, are made of a special alloy which is not affected by the atmosphere, and hence remains perfectly constant. The resistance in series with the measuring wire is placed at the back of the instrument, while the binding posts are along the lower edge and have a protecting cover of hard rubber. This voltmeter has no magnets, no coils and no iron, hence it is entirely unaffected by the strong magnets or large masses of iron which are always found in central stations. Another good point about this instrument lies in its being absolutely dead beat.

The pointer can only move as far as the expansion of the wire will permit, so that there is none of the annoying see-saw motion due to the momentum of the coils and armatures as found in other instruments. The needle merely swings over to the mark and stops there, making it possible



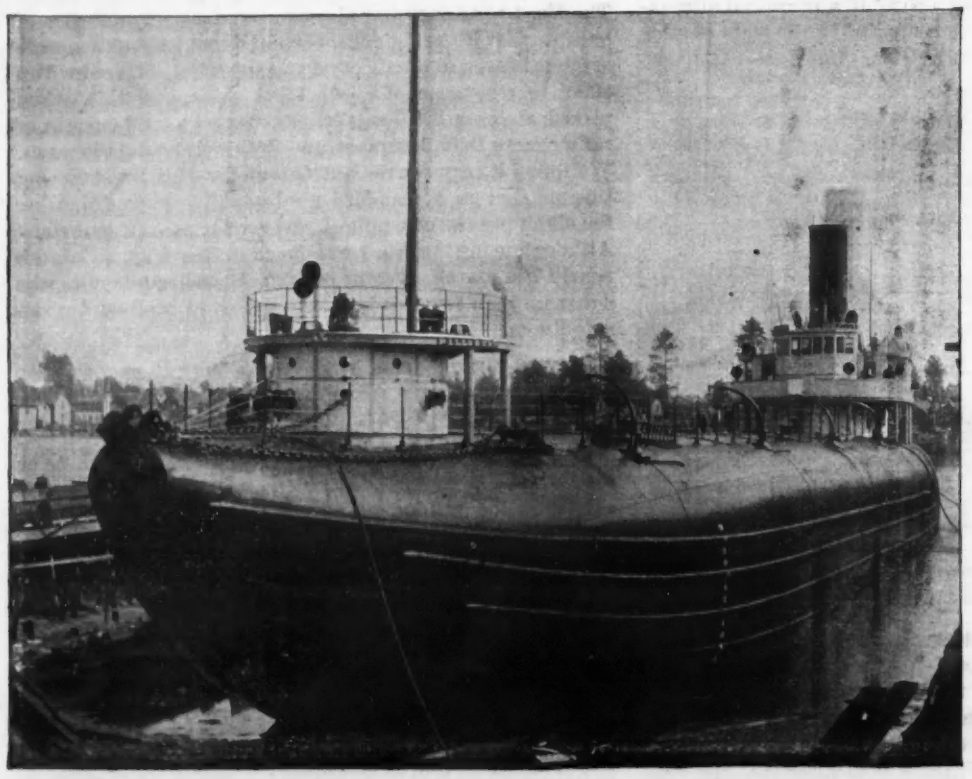
The Cutler Voltmeter.

to take a series of readings much more quickly than with other instruments. These voltmeters are made with either a single or double scale, and are calibrated to meet various requirements from 2½ volts for storage battery tests to 800 volts for street railway work.

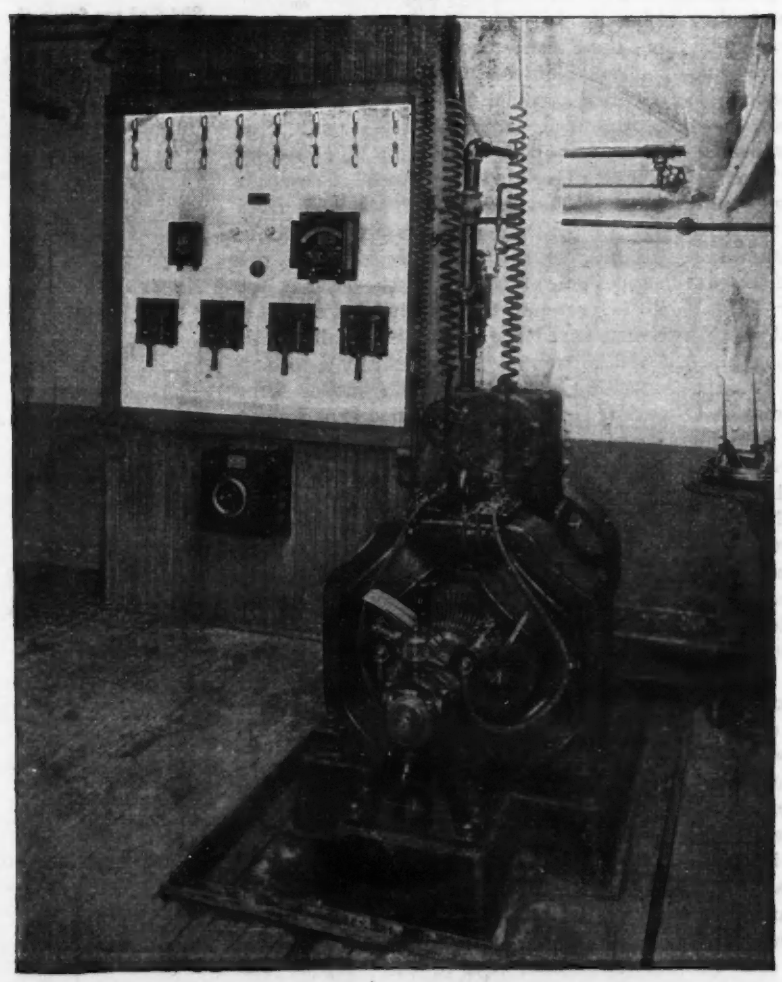
They are licensed under the Cardew hot-wire patent and are being introduced by George Cutter, of Chicago.

The Whaleback Steamship Pillsbury To Be Electrically Lighted.

This plant is the first electrical plant ever placed upon a steamship of the whaleback type, and was installed on the Pillsbury, when building at West Superior, Wis. Considerations of space entered largely into the question of this installation; and a small room eight feet square was all that could be spared. This precluded the employment of a belt connected plant, and a generating set of the General Electric Company's type was therefore adopted.



THE ELECTRICALLY LIGHTED WHALEBACK PILLSBURY.



ELECTRIC LIGHTING PLANT ON THE PILLSBURY.

The dynamo, of the four pole type, is of 150 lights capacity, and is directly coupled to a fifteen horse power engine, both having a common bedplate. Behind the engine and attached to the wall is the white marble incombustible switchboard. The dynamo room is located in the after portion of the vessel on the first lower deck.

The vessel is wired in the usual manner for one hundred and fifty lights, the best grade of wire for marine purposes being employed.

This installation, and that on the sister whaleback, the Washburn, was effected by the Isolated Lighting Department of the Northwest General Electric Company.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

[Inquiries from our patrons for information relative to stocks and bonds of the various electric light and power companies are solicited, and will be answered in this column.]

NEW YORK, Dec. 17, 1892.

GENERAL NEW YORK FINANCIAL STOCK MARKET.

The one prominent question in Wall street was that of finance. During the opening days upon the boom which started upon the death of Mr. Gould, prices advanced under the stimulus of good buying orders. On Wednesday, owing to the exports of nearly $2,000,000 in gold the market experienced a sharp reaction, which was intensified by the liquidation of the bull pool in some of the industrial stocks. The time was ripe for a decline, and the one which followed prompted the banks to descriminate against industrial collateral; this in turn accelerated the movement. Add to this the growing apprehension of leading financiers as to the money situation as reflected by a maximum rate of 25% and the almost positive certainty that $1,000,000 gold will be exported next week and the general reader can readily see that there is cause for great apprehension as to the future. The course of the market during the ensuing week will hinge entirely upon the question of finance. The exports of the coming week have been partially discounted, and if no gold goes the week after confidence will, no doubt, be partially restored. Prices have had a sharp reaction, and it is the opinion of a number of leading houses that they will halt, and after a few days inactivity advance. The Sherman silver law is a great hydra-headed monster, thoughts of which fill the minds of Wall street operators with apprehension. Its repeal would mean a restoration of confidence, a return of money to the country, and a jump in prices. However, it is almost certain that the present Congress will absolutely refuse to touch the measure owing to a clearly defined desire on the part of the administration to shift the responsibility.

General Electric.—The opening of this stock was at 113¼, and the highest point reached 115⅝, on Thursday, in anticipation of the 3½ per cent. dividend. On Friday quotations followed the course of the general market, the range being 112½ to 114¼. The stock sold ex-dividend to-day, dropping to 110. This is considered low even on an ex-dividend basis, when we consider previous quotations. It is a stock which is extremely sensitive to market conditions, and just at the present time is being neglected by the heavy bull interest. The announcement on Thursday that the United States Court of Appeals had decided to grant the company an injunction restraining the Sawyer-Man people from using the incandescent lamp, with certain equitable provisos (as will be seen by our news columns), had a stimulating effect upon the stock.

Edison Electric Illuminating of New York.—This stock showed remarkable strength throughout the entire week. The strong closing to-day at 110 in the place of the general panicky situation, showed unmistakably that it is an investor's favorite. Transactions were in limited amounts. Ten thousand of its first 5's sold at 109 to 109½. The company has declared regular quarterly dividends at 1½ per cent. and has recommended that the next quarterly dividend be 1½ per cent. This latter fact undoubtedly contributed materially to the strength of the security.

American Telegraph and Cable.—The highest price reached is 87½ on Monday, a quotation which was sustained on the day following. Later the price fell off to 85½. It has been argued that inasmuch as this stock is on a 5 per cent. basis, that it ought to sell as high as Western Union, and shows the tendency of a security of this class which is unaided by any artificial support or unnatural condition. It is believed that when the market becomes settled that it will approach very closely to the price of Western Union and that its condition will be brought about by Western Union approaching more nearly to the present price of American Telegraph and Cable.

American District Telegraph.—The highest point reached was 59 on Friday. There were no subsequent quotations, so that it is difficult to make a prophecy of the probable effect which the present depression will have on the price.

Western Union.—Last week we entered fully into the causes which brought about the advance in Western Union. It will be remembered that the starting point was 84½ and the highest point reached 96. It will not be out of place at this time to review these causes briefly. The buying was undoubtedly by parties who believed that the property would pass into the hands of a different management, as is usual in cases of this kind. There were numerous rumors afloat, the purport of which were that the Drexel-Morgan interest were to be given a representation. The buying extended to Monday, scoring for the stock a further advance to 98⅛. On Tuesday when we expected the reaction to come in, the price dropped to 95⅞. This was the range on Wednesday. On Thursday, because of the conditions set forth in the introduction, the price dropped to 94⅜. There was a further weakening on Friday in sympathy with the general market, and also under the hammerings of professional traders who put out a large portion of new stock. To-day the stock was very weak, closing at 93¼ bid, 93¾ asked. We have repeatedly emphasized the fact in these columns that Western Union above 85 was high, giving as our reasons therefor the increase in dividend requirements as shown by financial statements which are put out quarterly, setting forth the earning capacity. The recent spurt was very natural considering the fact that there was more or less belief that outside interests were attempting to secure control. This of course was accelerated by room traders, who felt certain that they had a good thing, and unless rendered support by inside interests the reaction will continue, bringing stock to a still lower basis. The course of the stock next week will depend very largely upon the course of the general market. From present indications we are very much inclined to think it will reach still a lower value. The company has declared its regular dividend of 1¼ per cent., payable Jan. 16. Books closed Dec. 20 and reopened Jan. 3. The statement showed net revenue for Dec. 31 quarter, $200,000,000. The estimated receipts for the Sept. 30 quarter were $2,200,000, and the actual proved to be $2,220,777. The company deducted from the surplus earnings $8,619,316, capitalized, leaving an estimated book surplus of $6,498,253 on Dec. 31.

The estimated statements for the quarter ending Dec. 31:

	1892.	1891.	1890.	1889.
Net revenue	$2,000,000	$2,000,000	$2,000,000	$2,000,000
Int. and sinking fund	243,355	243,300	242,483	253,850
Balance	$1,756 665	$1,757,700	$1,757,517	$1,766,150
Dividend	1,185,250	1,077,405	1,077,399	1.077,388
Surplus	$571,415	$680,295	$680,432	$688,762

Some surprise was manifest in certain circles this week at the failure of the Western Union directors to fill the vacancy occasioned by Mr. Gould's death. It is an open secret that President Norvin Green is a sick man, and it is believed that he will soon be compelled to retire from business life. As his successor the head of a prominent international banking house, and also of a leading brokerage firm, are mentioned. This house executed more orders for Mr. Gould than any other firm in the Street. With this in view it is assumed that no action will be taken toward filling the vacant directorship until this point takes more tangible shape.

Closing Quotations.—The following were the closing quotations of electric stocks on Saturday, Dec. 17, 1892, and the range for the week in New York:

NEW YORK QUOTATIONS.

	Par.	Capital outstanding.	Lowest.	Highest.	Bid.	Ask'd.
American District Tel.	100	3,825,000	56	59	56	56½
American Tel. & Cable	100	14,000,000	85	87½	85	85¼
Central & So. Am. Tel.	100	6,000,000	....	....	105	115
Commercial Cables	100	7,716,000	....	....	176	180
Gold Stock & Tel	100	5,000,000	....	....	100	103
Bonds	500	500,000	....	....	100	....
Mexican Telegraph	....	.....	....	....	175	190
Northwestern Telegraph	....	.....	....	....	102	....
Postal Tel. & Cable	....	10,000,000	....	....	62	64
Southern & Atlantic Tel	25	948,775	....	....	78	84
Western Union Tel.	100	96,199 852	93⅛	93⅝	93¼	93½
Real estate bonds	1,000	1,219,000	....	....	....	..
Debenture bonds	1,000	1,920,000	....	....	....	..
Collateral Trust 5's	1,000	8,184,000	106	106	....	..
North American	100	39,767,200	10	12	11	11½
Brush Ill. Co. of N. Y.	50	1,000,000	....	....	30	60
Edison El. Il. of N. Y.	100	6,500,000	108	111	110½	111
" " 1sts	....	.....	109	110	....	.
" " Deb's	....	.....	....	....	....	....
Edison El. Il. of Brooklyn	100	750,000	....	....	85	90
" " " " Chicago	100	750,000	....	....	130	145
" " " " " Boston	....	.....	....	....	115	125
Edison El. Lt. Europe	1000	2,000,000	....	....	2	6
" Bonds	....	30,000	....	....	65	80
Edison Ore Milling Co.	....	2,000,000	....	....	15	20
East River El. Light	100	1,000,000	....	....	....	65
General Electric	1,000	50,000,000	115¼	111	110	111
Debenture 5's	....	10,000,000	101½	101¾	....	....
Automatic Exhibition Co.	....	2,500,000	....	....	3	5
Mt. Morris Electric	....	500,000	....	....	....	65
N. E. Phonograph	....	2,000,000	....	....	2	4
N. Y. Phonograph	....	2,000,000	....	....	2	5
N. American Phonograph	....	2,000,000	....	....	4	6
Westinghouse E. & M. Co. 1st p. 7 per cent., Cum.	50	3,717,253	....	....	....	....
E. & M. Co. Assg.	50	5,038,116	....	....	....	....

BOSTON Mass., Dec. 17, 1892.

The market for the week has been discouraging and unreliable all around. It cannot maintain buoyancy indefinitely without regard to the dominant factors in the financial situation, and so at last it succumbed to the forces undermining the strengthand confidence of supporting elements. In sympathy with the New York market, prices have fallen with the large amount of liquidation forced upon the market, due to tight money, and exports of gold. The local money market is not particularly stringent, since large amounts of funds are just now coming in. The C., B. & Q. dividend adds many hundreds of thousands, also the payment for general electric bonds, and also the recent Connecticut River railroad stock deal brings a large block of money from out of town. Street loans range from 5 to 6 per cent., and except for a slight hardening in the rate there has been no material change. The bank statement at the beginning of the week, when the Comptroller's call was issued, showed a decrease in loans and individual deposits, but there are gains in other items.

Among the dividends declared this week is one on Fort Wayne Electric Company's "Series A," of 16 cents per share, payable Jan. 2 to stockholders of record Dec. 17.

The Electric Stocks.—It has been another active week among the Electrics, and all have received their individual share of trading and consequent fluctuation.

Westinghouse does not reflect in any great measure the recent lamp decisions, which it was predicted would be so disastrous to its business. The company sees more than one way to get around the direct influence of this dicision against it, and "on the street," where reports are sifted pretty thoroughly before much credence is placed in them, there is a feeling that a consolidation is actually near at hand. Straight advices are given that the stock is a good purchase. It has been erratic during the week, and shows a net loss of three points, which, according to the general opinion, renders it three points better to purchasers. A large block of the stock was thrown suddenly upon the market, and seemed to display signs of distress within the pool, but what ever may have been the source of the stock it broke the price to 32, from which a rally may be expected very soon.

General Electric has also received a large share of attention this week, in one day gaining two points to 115⅝, which it has since lost from forced liquidation on the part of smaller holders carrying it back to 112¼. The money for the new bonds is being paid in now, and for a time at least the coffers will be full, and nothing more in the way of "rights" may be looked for, for some time to come.

BOSTON QUOTATIONS.

	Par.	Capitalization.	Highest.	Lowest.	Bid.	Ask'd.
Thomson-Houston Elec.—Series Co	sh	40,000	9½	....	9	10
Thomson-Houston Elec.—Series D	sh	120,000	8	7⅝	7¾	7⅞
Thomson Elec. Weld	100	1,000,000	....	....	....	....
Thomson European Elec. Weld	100	1,500,000	....	....	7½	8
Westinghouse Elec.—New Com.	..	6,000,000	35	31½	31½	32
Westinghouse Elec.—Pfd.	..	4,000,000	49¼	48½	48½	49
General Electric	..	30,067.200	115⅜	111¼	111½	112
" " Pfd	...	4,136,300	116	115	115	115½
Fort Wayne Elec.	25	4,000,000	13	12¾	12¾	13⅛
Fort Wayne Elec.—Ser. A.	sh	80,000	8	7⅞	7⅞	8
Detroit Elec.	20	750,000	...	....	4	5
West End St. Ry. Co.—Com	50	7,150,000	*70¾	69¾	70	70⅛
West End St. Ry. Co.—Pfd	50	6,400,000	*85	84¾	84¾	85
American Bell Tel	100	15,000,000	2 07½	207	208	209
Erie Tel. & Tel. Co.	..	4,800,000	50¾	49½	49½	50
Mexican Tel. Co.	10	1,280,000	90c.	85c.	85c	1.00
New Eng. Tel. & Tel. Co.	..	10,304.600	59	58	58½	59½
Tropical Tel. Co.	10	400,000	....	....	....	....

*Ex. dividend.

Bell Telephone's continued strength at 209 is very noticeable in view of the tremendous raids that have assailed almost every stock in the market. A sufficient reason may be found, however, in the recent declaration of an extra dividend of three dollars per share. It will be paid Jan. 16 to stockholders of record Dec. 31 This makes a total of $18 in dividends for the year, equaling previous years, and proving the truth of the opinion of the friends of the stock, which was advanced in July, when a change was made from the usual plan of paying the extra dividends. It had been the custom to pay four quarterly dividends of $3 each, with an "extra" $6 in July, and, when only $3 was paid on the "extra" last July, it served as sufficient argument for some to depress the stock with reports that the old rate could no longer be maintained from the earning capacity of the company, on the increase of stock, which was just then being issued. Though the stock was easily pushed down to 192, still the friends of the company, and those intimate with its real condition fully understood that the change in paying the dividend was no criterion by which to judge that it could or could not be earned as in the past. As was stated then in THE ELECTRICAL WORLD'S columns, it was simply a change in the policy on the part of the company, so that those who were subscribing to the new stock in the summer might have the advantage of one-half of the extra dividend in the winter, and therefore it was made in two payments. As the life of the telephone patents now becomes lessened to a very short time, the financial policy and earning capacity of this great corporation becomes an important and interesting feature on the street. At present there is certainly no depreciation in its strength, and it is always a good purchase at any market price.

CHICAGO QUOTATIONS.

Following are the quotations of telephone and electric stocks furnished THE ELECTRICAL WORLD by C. V. Banta, Jr., 167 Dearborn street:

Telephone Stocks:	Bid.	Ask'd.	Electrical Stocks:	Bid.	Ask'd.
Chicago	205	....	Chicago Arc Light & Power Co.	106	106½
Central Union	....	57½	Chicago Edison Co.	170	....

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, Dec. 19, 1892.

John A. Roebling & Sons' Company about a week ago laid a three-pair telephone cable across the North River from New York City to the Jersey shore.

The Albany Lubricating Compound Company, 313 West street, New York City, is getting out a handsome calendar which will be sent to any electrical engineer on application.

Electricity for the Bridge Cars.—President Howell, of the New York & Brooklyn Bridge Company, has announced that within two years electricity will be the motive power of the bridge cars.

The U. S. Electric Railway Company, 10 Wall street, New York City, of which Mr. Lemuel W. Serrell is general manager, is laying the track of the Paterson & Little Falls Railway at the rate of 1,000 feet per day.

Charles E. Chapin, 136 Liberty street, New York City, purchasing agent of electrical supplies, reports business good in all parts of the country. Mr. Chapin takes orders for the purchase of central station supplies ranging from insulating tape to steam engines.

Mr. W. L. Morse, representative of the Detroit Electrical Works, was in the East last week and reports their business very flourishing. They soon expect to confine their supply business only to goods of their own manufacture and for which they are making extensive preparations.

Mr. Charles Blizard, formerly connected with several western electrical enterprises, is now with the Franklin Electric Company, 106-108 Liberty street, New York City, as secretary, and although in New York but a short time Mr. Blizard has made a great many friends and has their wishes for his success.

The Anglo-American Electrical Manufacturing Company, 135 Liberty street, New York City, recently issued a descriptive catalogue of the apparatus manufactured by it, including dynamos and motors, bells and annunciators, insulators, push buttons, storage batteries, telephone and telegraph sets and the Radiant incandescent lamp.

Mr. R. J. Britton, manager of the Safety Electrical Company, 88 Mechanic street, Newark, N. J., who has been confined to his home during the past few months, has fully recovered, and is now booming the specialties of his company. This company is placing upon the market a new motor of from 1 to 10 h. p., the special features of which are its simplicity in construction and its general efficiency.

J. P. Hall, electrical engineer, 143 Liberty street, New York, City, recently installed at the Imperial Hotel four 80-light machines. He has also placed a large plant in the Bank of New York, electrically equipped the Clyde line steamers which ply between New York & Jacksonville, and installed large plants in the Liverpool & London Globe Insurance Company's building, and the barrel factory of the Standard Oil Company.

The Overhead Wire War.—A meeting was held in Mayor Grant's office this week in reference to the removal of the overhead wires, and to secure some adjustment of the difficulties between the various companies and the Board of Electrical Control. Mr. S. S. Wheeler, on the part of the Board, read a statement denying all charges of blackmail and showing that no discrimination had been made for or against any of the electrical companies. Judge Kelly, the counsel for the Thomson-Houston company, denied that any charge of blackmail had been intended, and the matter was settled by the Mayor ordering Chief Inspector Byrne, of the Subway Commission, to go with Superintendent Dexter, of the Thomson-Houston company, and point out the alleged violation of the law and see if some arrangement could not be made to avoid cutting down the wires.

Street Lighting Bids Too High.—The United Illuminating Company last week sent in a bid for 77 lamps at 50 cents per night, the Manhattan company for a like number at the same price, the Thomson-Houston company for 45 cents, and the Brush company for 42 cents. Representatives of all these companies stated that there were new lamps in localities where there was no demand for electric light for commercial purposes, and that they could not afford to supply the lamps at the usual rate of 40 cents per night. The 50 cents per night bids were rejected, which leaves the following streets unlighted: Lexington avenue, between Thirty-fourth and Fifty-ninth streets; Thirty-sixth street, between Madison and Fifth avenues; Twenty-fifth street, between Broadway and Sixth avenue, and Twenty-sixth street, from Fifth to Sixth avenues. The bids of the Thomson-Houston and the Brush companies were laid over. Commissioner Gilroy declared that there was an evident attempt on the part of the companies to force the city to their terms, although they held valuable franchises from the city. Secretary McCormick announced that residents in Fifth avenue wanted more light than they obtained at present from the new system of double lamps, to which the mayor replied that they could not have additional lights without paying for them. There have been 1,000 more electric street lights this year than last, and a consequent diminution of the number of gaslights by 2,000. The increase in cost was about $97,000. The bids of the gas companies and those of the electric light companies which correspond with prices paid for 1892 were accepted.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 31, CITY TRUST BUILDING, 927 Chestnut St.,
PHILADELPHIA, Pa., Dec. 17, 1892.

The Iron City Electric Company, of Pittsburgh, Pa., will soon be re-organized.

The Hall Steam Pump Company, of Allegheny, Pa., reports business exceedingly good.

Mr. Hershey, of the Harrisburg Foundry and Machine Works of Harrisburg, Pa., was in New York last week on a business trip.

The Purity Oil Filter Company, of Pittsburgh, Pa., has recently received several order for its filters, some of which are very large.

Mr. James W. Bach, secretary and general manager of R. Thomas & Sons' China Works, East Liverpool, O., reports business very brisk.

Marshall Bros., manufacturers of electric elevators, contemplate a modification in their electric elevator, which they think will be a very great improvement.

The U. S. Supply Company, 154 Fifth avenue, Pittsburgh, Pa., is making a test of its new railway joint, and expects to have the same on the market in a few weeks.

The Solar Carbon and Manufacturing Company, of Pittsburgh, Pa., is away behind in its orders, notwithstanding the fact that its men are working double time.

The Electrical Supply and Construction Company, of Pittsburgh, Pa., reports business exceedingly brisk, so much so in fact that it is impossible to fill orders promptly. This company carries a very fine line of general electrical supplies.

Mr. Harry W. Anderson, secretary and manager of the Harrisburg Boiler and Manufacturing Company, of Harrisburg, Pa., reports that the business of the company for the past year has been very encouraging, having filled some very good orders recently.

Mr. Humbird, of the Washington Carbon Company, of Pittsburgh, Pa., has just returned from a business trip. Mr. Crider, of this company, reports some very large orders the past week, and the company is working its men overtime in order to keep pace with the increase of business.

Mr. J. W. Marsh, vice-president and general manager of the Standard Underground Cable Company, of Pittsburgh, Pa., has just returned from a business trip, the result of which is said to be very gratifying. The business of this company has thus far this year greatly exceeded that of last.

The Pittsburgh Reduction Company, manufacturer of aluminium, has been compelled to extend its facilities, consequent on the increase of business. After this extension has been completed the output will be very much increased, and thus enable the company to fill its orders more promptly.

Mr. J. L. Hay, manufacturer of tablet boards, of Pittsburgh, Pa., is fitting up his shop with additional machinery of the most modern type, suitable for the manufacture of his tablet boards, the demand for which is growing rapidly. Those boards are used in connection with wiring first-class business places and residences, and are becoming very popular.

The Supply Manufacturing Company, of Pittsburgh, Pa., will be compelled to enlarge its plant and thus increase its output should business continue to increase in the same rate as it has within the past few months. This company makes a specialty of manufacturing commutators of all sizes and has the reputation of turning out first-class work in every respect.

The Trolley's First Day in Philadelphia.—Catharine and Bainbridge streets were fairly alive with people on Thursday, the 15th inst., when the trolley system made its bow to the Philadelphia public. It vindicated itself in an hour, and ere the day was done not a man who traversed the line had aught to say against the road or the system. From the several thousand people who rode over the entire route "just to try it," not a complaint was heard. Every car was crowded to its utmost capacity after six o'clock in the morning until 8 o'clock in the evening, and fully 20 cars would be needed on the line if this enormous travel continued. Twelve cars were run throughout the day, and not a hitch of any description occurred, although the cars were run on an irregular schedule. The system used is that of the Westinghouse Company. Henry W. Banister, vice-president of the Westinghouse Electric Company; Geo. D. Widener, of the Traction Company; Chas Bragg, the resident manager of the Westinghouse Company, and F. Uhlenhaut, of the Field Engineering Company, rode over the entire route. Mr. Banister examined everything minutely. After having satisfied himself that everything was as near perfect as possible, he told Mr. Widener that he was prepared to demonstrate to any one that the Catharine and Bainbridge Street Line is the very best system in America in construction and equipment.

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 28, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., Dec. 17, 1892.

Mr. H. S. Geer has recently joined the Boston staff of the Eddy Electric Manufacturing Company.

Mr. B. E. Davis, the popular representative of the Pass & Seymour Company, of Syracuse, is in the city.

Mr. Charles H. Sutherland, representing the Goodrich Hard Rubber Company, is calling on the trade in Boston.

Mr. Geo. B. Damon has associated himself with Gilbert Rodgers, electrical engineer, with offices at No. 19 Exchange Place, Boston, Mass.

Newton Rubber Company, Boston, Mass., reports a very satisfactory business for storage battery cells and for its specialty of rubber springs for street railway cars.

The Massachusetts Electrical Engineering Company reports a very satisfactory business for the last month. This company's reports on matters of inspection, and in other lines which it makes a specialty of, are accepted by the trade as authority.

The Mather Electric Company's apparatus, it will be remembered, was selected by the Mass. Charitable Association to furnish power for the Mechanics' Fair, which has just closed. As a result of this practical exhibit, the company is receiving many orders.

The Pettingell-Andrews Company, of Boston, Mass., is doing a prosperous trade. Its specialties are well known in the electrical field, and the Interior Conduit Company of New York is fortunate in securing this company to handle its conduits for New England.

The Boston Braid Manufacturing Company, Boston, Mass., is the only manufacturer of braided silk for filament purposes in the United States. Incandescent lamp manufacturers who have adopted braided silk filaments are highly pleased with their performance.

The American Circular Loom Company, Boston, Mass., the well known insulated wire manufacturer, reports the sale for its Canvas Jacket brand, especially through the New England and Middle States, as running ahead of previous years and its western trade is rapidly growing.

The Samson Cordage Works, Boston, has recently enlarged its plant to meet the demand from the electrical field, as it has found it hard at times to fill the orders promptly. The braided cord of its make is used principally for hanging arc lamps, covering field magnets and for controlling the trolley.

The Eastern Electric Light and Storage Battery Company, Lowell Mass., manufacturer of the new 1891 model "Sorley" storage battery, is receiving many orders. These batteries are especially adapted for service in lighting mills, public buildings, private residences, schools, churches, institutions, etc.

The Evans Friction Cone Company, of Boston, Mass., has many horse power in use driving dynamos where open belting and high speeded gears are not practicable. In operating driving machinery, which requires a variable speed while running, and machinery requiring steady speed when driven by unsteady power, it can be controlled by a governor automatically or by hand.

The Heintz Electric Company, Lynn, Mass., which has recently started the manufacture of electric instruments, is making volt and ampère meters for alternating and direct currents of all capacities, which are accurately calibrated and very sensitive to variations. It also manufactures automatic fuse cut-outs, fan motors, with universal adjustment; reflecting galvanometers, watt-meters and small alternating (4 h. p.) generators.

WESTERN NOTES.

Branch Office of The Electrical World,
465 The Rookery, Chicago, Dec. 17, 1892.

Mr. Dan Hemingray, of the Hemingray Glass Works, Covington, Ky., has been in Chicago some days during the past week, looking up the insulator trade.

At the Meeting of the Chicago Electric Club on Monday, Dec. 19, Mr. C. J. Field, of New York, will present a paper entitled "An Ideal Central Power Station."

Mr. J. F. Kester has resigned his position with the Kester Light and Manufacturing Company, recently removed from Chicago to Ironwood, and is at work perfecting several electric specialties.

Ten new electrical stamping machines were received at the postoffice in Chicago, on Tuesday last, and they will be put in position by an expert from Boston. They will greatly facilitate the handling of mail, doing away with the necessity for one handling of first class matter.

Mr. W. W. Splane, telegraph superintendent for the National Transit Company, with headquarters at Oil City, has been in Chicago for some days. Mr. Splane also has charge of the electrical department of the Standard Oil Company.

Obituary.—M. M. M. Slattery, the inventor of the Slattery induction system of the Ft. Wayne Electric Company, died at Ft. Wayne on Tuesday of this week. Mr. Slattery was a well known figure at the meetings of the National Electric Light Association, and his name was more widely known as the inventor of numerous electrical appliances in daily use in electric lighting stations.

The Jenney Electric Motor Company, Indianapolis, Ind., is fortunate in securing the services of Mr. Carl Kammeyer, who for several years has been the electrician of the National Electric Manufacturing Company, at Eau Claire, Wis. Mr. Kammeyer's extended experience, both in laboratory, factory and installation work combined, will enable him to do good work for the Jenney Company.

The National Electric Manufacturing Company has recently sold through its Chicago agency, Mr. Paul Bossart, manager, the following apparatus: Two 1,000-light machines to a local company at Kenosha, Wis.; one 500-light machine to Covington, Ind., and one 750-light machine to parties at Auburn, Ind. The factory at Eau Claire, Wis., is reported as being 60 days behind on orders already on file.

The Commercial Electric Company, of Indianapolis, Ind., has just sold one of its new 200 light generators to parties in New Orleans, through a local supply house that has recently been organized in that city. Mr. A. D. Adams, the manager of the Commercial company, is the inventor of the type of machines being manufactured by his company, and it is believed that they have some strong points that will insure an active demand.

Mr. Edw. R. Grier, with an office at No. 1522 Monadnock Building, will represent Russell & Officer, of Denver, Colo., in the sale of their automatic switch. Mr. Grier is a brother of Thos. G. Grier, well known as the Western representative of the Bryant Electric Company, and has recently moved to this city from Philadelphia. Mr. Grier is a young man of good character, possessing excellent business qualifications, and will undoubtedly succeed in his new undertaking.

Dr. John McKinlock, well known for his connection with the Central Electric Company, of Chicago, has resumed the practice of medicine, and has opened a suite of offices in the Venetian Building, No 34 Washington street, Chicago, where many of his friends are calling upon him. Before leaving Detroit Dr. McKinlock built up a practice so extensive that his health became affected through overwork, and so for nearly two years he has been recruiting his health while traveling for the Central Electric Company.

William A. Beach, for thirty-five years manager of the Toledo, O., office of the Western Union Telegraph Company, died very suddenly in that city on Tuesday evening last. Mr. Beach was one of the oldest men in the employ of the company as to years of service, and was highly respected by the business men of Toledo. F. G. Beach, General Superintendent of the Central Union Telephone Company, Chicago, and George A. Beach, of the Iowa Phonograph Company, Sioux City, Iowa, are brothers of the deceased.

Prof. Elisha Gray has perfected the telautograph, and an instrument in many ways more remarkable than the telephone is in a very short time to be given to the public. During the past week W. H. Eckert, general superintendent; John W. Johnstone, general manager, and James M. Ormes, from the main office of the company, at No. 80 Broadway, New York, have been in Chicago in consultation with the inventor, and it is expected that a public exhibition will be given in a few days. Very extensive shops have been built at a suburban town—Highland Park—and the manufacture of the instruments has already commenced on a large scale.

Mr. J. W. Marsh, vice president and general manager of the Standard Underground Cable Company, Pittsburgh, has been in Chicago and vicinity for some days. Mr. Marsh is on a tour of inspection, his company having secured through Fred. Degenhardt, manager of the Chicago agency, three very large contracts that are now well under way, as follows: The Chicago Telephone Company, 170,000 feet of telephone cable; the Omaha & Nebraska Telephone Company, cable for the complete installation of the telephone system for the city of Omaha, and the cable for the complete installation of the Indianapolis Light and Power Company's plant.

Mr. C. A. Daigh, president and general manager of the National Electrical Manufacturing Company, Eau Claire, Wis., spent two or three days last week at the Chicago office of the company, in the Pullman Building. While here Mr. Daigh purchased two car loads of new machinery, lathes for heavy work, etc., to equip a very large addition that has recently been built to the works at Eau Clare. The company, under Mr. Daigh's management, has largely increased its business, and the outlook for the future is most promising. Mr. Daigh and Mr. Morgan Brooks, who is associated with Mr. Daigh at St. Paul in the management of the Electrical Engineering and Supply Company in that city, as well as in the management of the National Company at Eau Claire, are to be congratulated upon the success met with in the improvement of the companies mentioned.

The Long Distance Telephone Company, with wires connecting the East and the West, is receiving more than the expected patronage, and additional wires will soon be strung between the terminals and between such intermediate cities as Cincinnati, Toledo, Detroit, Pittsburgh, and many others of less note. During the severe storm that raged throughout the West on Wednesday of last week, the telegraph service, including the New York market quotations, was entirely suspended for two hours, something that has not occurred before in five years, and during this time the telephone circuits were in perfect order, many of the large commission houses in New York and Chicago making most satisfactory use of them. The office at the Chicago end, with Mr. Stoughton Walker, manager, is at No. 10 Quincy street, only a step from the Board of Trade. This use of the telephone is destined to be of great value to the commercial interests of the country.

Cincinnati, O., Dec. 17, 1892.

The Queen City Electric Company has secured a contract for wiring the Gibson House for 1,500 incandescent lights. The wires will be run in interior conduits, using the Interior Conduit and Insulating Company's system, which will be furnished by that company's Cincinnati agents, the Post Glover Electric Company. The best possible work will be done on this installation, and it is expected that it will stand any inspection that the underwriters see fit to order.

The New Odd Fellow's Temple will be equipped with interior conduits, using the Interior Conduit and Insulating Company's system. The wiring for 4,000 lights and the placing of the conduits is being done by Mr. Luke Lilly, formerly city electrician, which is a guarantee that the work will be well and carefully done. The current will be furnished by an isolated plant, the apparatus for which has not yet been put under contract. Cincinnati is becoming noted for fine installations of this character, but when this plant is completed it is believed that there will be no finer one to be found in this city or elsewhere.

The Jones Bros. Electric Company is fitting up the elegant new hotel Stratford, in the new Walnut Street Theatre building, with calls, fire alarm, etc. The latest improved apparatus made by this company is being used, and the plant is to be a model one in every way. Jones Bros. have been very successful in the extension of their central station lighting plant, until now they have upwards of 5,000 lights installed. They have also made a specialty of supply current for power and fan motor service, and have been most liberally patronized, contracts having been made for the entire capacity of the plant.

J. G. White & Co., New York, electrical engineers and contractors, opened a branch office in Cincinnati, on Dec. 1, with Mr. G. M. Gest as local manager. The company has a wide reputation, and under Mr. Gest's management will undoubted secure a profitable business in Cincinnati and vicinity from the start. Mr. Gest is a pioneer in street railway construction, having been connected with the first Daft system in Baltimore many years ago and has been continuously in the harness ever since. A fine office has been fitted up in the Perin Building and after a short time Mr. Gest will, personally, be prepared to take contracts for road bed and track work.

The La Boiteaux Fan and Motor Manufacturing Company has had a very successful season's business in the introduction of both an oscillating and revolving fan, specialties controlled by patents issued to Mr. Frank La Boiteaux. Several improvements will be made in the patterns to be put on the market next year, making the fan a most complete one. This company is also bringing out a number of other electrical specialties in order to keep the men employed during the fall and early winter months, when motor fans are not in demand. Henry Varwig, the president of the company, is a well known manufacturer, having for many years been at the head of the Varwig Manufacturing Company, engaged on a large scale in the making of brass faucets and other articles sold to brewers.

The Card Motor and Dynamo Company has purchased a site for a new factory and office building, at the southeast corner of Hunt street and Broadway, near the business centre of the city, and has the improvement well under way. The building is to be 86 feet on Broadway and 175 feet on Hunt street, three stories in height. The contract calls for the completion of the work on March 1 next, and it is expected that very soon after that date the company will move from its present quarters. Under Mr. Wilshire's careful and conservative management the Card company has come to be known as one of the prosperous corporations of the city and when located in the new building it will enjoy facilities second to that of no electric company in the West. Mr. Wilshire and his associates are to be congratulated on their success.

The Electric Railway Equipment Company, Cincinnati, O., has been manufacturing for some time a wrought iron or steel tubular pole for street railway and electric lighting purposes that appears to be steadily working its way into popular favor. The pole is made in short sections, as many others have been, the principal merit claimed for it being the manner in which the sections are joined together, viz., by means of a very ingenious combination of a ring and screw, making the pole a very strong one. There has been made to date by this company 3,000 of these poles that are now in use in the city of Cincinnati alone, 1,500 used in the reconstruction of the street railway system in Evansville, Ind., and many more in other cities. Business in other specialties manufactured by this company, and in the general line of street railway supplies, is reported as being good, and the outlook for the beginning of the new year is very bright.

Markle & Harnish, representing the Siemens & Halske Company, of America, in ten Central and Southeastern States, are pleasantly settled in a suit of rooms on the fourth floor of the Perin Block, at the corner of Fifth and Race streets. Mr. Markle has a national reputation, having won his spurs at an early day in the employ of the Edison Isolated Company. His claim to having sold and installed the first electric lighting plant in Chicago (in the old Norton Mill at the Madison Street Bridge), and to having sold and installed the first plant in Michigan (at Ludington) remains undisputed. Mr. Harnish has been, until recently, identified with the local street railway interests at Grand Rapids, Mich., having sold out when the recent consolidation took place. Both of these gentlemen have had a wide business experience, and the Siemens & Halske Company has made no mistake in confiding its interests in this, one of their most important districts, to their care.

News of the Week.

THE ELECTRIC LIGHT.

Woodstown, N. J., wants an electric light plant.

Herne, Tex., has recently secured an electric light plant.

Franklin, N. Y., is taking steps to secure an electric light plant.

Hartford City, Ind., is to have a system of electric lights in the near future.

Brownwood, Tex.—It is more than probable that an electric light plant will be built.

Galva, Ill., has concluded that it must have an electric light plant in order to keep up with its rivals.

Salt Lake City, Utah.—An effort is being made to place all the telephone, telegraph and electric light wires underground.

The People's Electric Light Company, of Canada, Mich., has purchased a lot, and will proceed at once to the erection of a central station.

THE ELECTRIC RAILWAY.

The Mohawk (N. Y.) and Ilion Street Railway Companies propose to equip their roads with electricity.

The State Subway and Electrical Commission, of New Jersey, has granted permission to the North Hudson County Railroad Company to erect a trolley road along two blocks in the uptown section of Hoboken.

The Trumbull Electric Company has never undertaken the construction of the electric road between Warren, O., and Niles, and it is stated that a new company composed of local capitalists is now prepared to build a road unless the Trumbull company immediately commences work.

Rochester, N. Y.—Arrangements are nearly completed for a new electric railway company, whose lines will run from the liberty pole on East Main street to Glen Haven, Newport and Sea Breeze, comprising about 30 miles of track. The promoters are Charles Goetzman, Jos. C. Tuer and Emaunel Linder. The right of way has practically been secured.

Baltimore, Md.—The president, treasurer and engineer of the Edmondson avenue, Catonsville and Ellicott City Railroad Company have made a tour of inspection over the proposed route for that road through Howard and Montgomery counties, Md., as far as Ashton, at which point it is hoped to connect with the road from Washington.

The Trolley at the Park Plaza.—Judge Bartlett of the Supreme Court has granted to the Brooklyn City Railroad Company an order to show cause why Park Commissioner D. B Brower should not be perpetually enjoined and restrained from interfering or obstructing the introduction of the trolley system on Flatbush avenue, along the side of the Park and the Plaza.

The Atlantic Avenue Railroad Company, of Brooklyn, has indicated its intention of stringing trolley wires in Liberty avenue, although no franchise for that territory has been granted. The company claims that this is an extension of the Putnam avenue line, granted in an act of the Legislature, passed June 10, 1873, which has been indirectly turned over to the company.

The Lake Roland Elevated Railroad is rapidly pushing the work on its elevated structure on North street, Baltimore, Md. This portion of the road is about 4,000 feet long and will be entirely of steel; it is light in appearance but is well designed. The Pennsylvania Steel Company is furnishing the material and erecting the structure. The power station for this road is well under way.

The Baltimore & Curtis Bay Road recently tested a new electric snow sweeper purchased from Lewis & Fowler, of Brooklyn, N. Y., and found it to work satisfactorily. The body of the car is elevated above the trucks in order to give room for the revolving rattan brushes, which are driven by an independent motor of 25-h. p. Two 25 h. p. motors supply the motive power for the machine, which weighs 23,000 lbs., complete. A scraper arranged on the side assists in clearing the track, and canvas aprons on the platforms keep the snow from flying about when the car is used in the city streets. Part of the trip was made at a rate of 10 miles an hour.

The Kings County Electric Railway Company, of Brooklyn, N. Y., has filed a certificate to further extend its railways for a distance of 16 miles. The new tracks are to be laid from Cooper avenue, along Hamburg avenue to Evergreen Cemetery, from Cooper avenue along Hamburg, Morgan, Johnson Union avenues, South Fifth street, Marcy avenue, Broadway, South Eighth street, Kent avenue to foot of Broadway; from Marcy avenue and South Fifth street, along Marcy, North Second; also from Broadway along Marcy to Fulton, New York avenue, Church avenue, to Ocean avenue, to Sheepshead Bay; from Rockaway avenue, along East New York avenue and Liberty avenue to Brooklyn City Line; from Rockaway avenue through East New York avenue, Douglass street, Prospect Park Plaza, across the Plaza to Union street.

PERSONALS.

Prof. R. H. Thurston, of Cornell University, has been made a member of the Advisory Council of Engineering and Marine Architecture of the World's Columbian Exposition.

Mr. William H. Butler, formerly at the Edison Works, at Schenectady, N. Y., has recently become connected with the Akron Electrical Manufacturing Company, at Akron, O., as assistant manager. The business of this company will be reorganized and its works considerably extended.

Mr. John Beattie, president of the Fall River (R. I.) board of aldermen, has applied for a patent on a contrivance which is designed to overcome the difficulties of induction on telephone circuits, and local capitalists have agreed to support the enterprise. Mr. Beattie is the inventor of the Beattie zinc, and also a self-governing electric motor A public exhibition of the new devices will be given in a short time.

The Mr. Herz who is at present figuring in the Panama canal scandal in Paris is Dr. Cornelius Herz, the sole proprietor of one of the leading French electrical journals, *La Lumière Electrique*. He formerly lived in California, and during the early days of electrical engineering moved to Paris, where he bought out that paper and made Count du Moncel editor-in-chief. He should not be confounded with the Dr. Heinrich Hertz, of Bonn, Germany, who is well known for his interesting researches in electrophysics. The latter is no relation to Dr. Cornelius Herz.

Industrial and Trade Notes.

Church & Sleight, 109 Fulton street, New York city, dealers in electrical supplies and specialties, report business as very brisk.

The C. McIntire Company, Franklin street, Newark, N. J., reports great demand for its celebrated connectors and terminals.

The Positive Lock Washer Company, of Newark, N. J., S. D. Barnett, manager, is selling large numbers of its washers to railroads throughout the country.

The Typewriter Exchange, 10 Barclay street, New York City, of which Mr. Geo. A. Hill is manager, is selling a large number of new, fastest model Remington and other typewriters.

Messrs. J. G. White & Co., 29 Broadway, New York City, electrical engineers, whose specialty is the construction of electric railways, report business exceedingly brisk for this time of the year.

The Caldwell Boiler Company, 15 Cortland street, New York City, has been awarded the contract for supplying 600 h. p. of boilers for the Metropolitan Realty Company's new 14-story building.

The Berlin Iron Bridge Company, East Berlin, Conn., has secured the contract for three new iron buildings and iron roofs for the East River Gas Company, to be constructed at Ravenswood, L. I.

Gould & Eberhardt, of Newark, N. J., report a bright outlook for their specialties, which include gear cutters, shapers, drill presses, lathes, planes, etc. At present this firm is receiving its usual share of large orders.

The McCreary Electrical Company, of 136 Liberty street, New York City, is overwhelmed with orders for its various well known specialties. Mr. McCreary has lately found it imperative to refuse several large "rush" orders owing to the amount of work already on hand.

The Mather Electric Company, 97 Nassau street, New York City, has closed a contract with Messrs. L. Sternberg & Company, Newark, N. J., for one 250-light Mather dynamo; one 25-h. p. Ball engine, and one 35-h. p. Hughes & Phillips vertical boiler. The installation is to be completed by Jan. 15, 1893.

James A. Trimble, 220-22 East Twenty-eighth street, New York City, manufacturer of cars, expects to enlarge his plant after Jan. 1. He is very busy, and has a number of large orders now on hand. A number of cars were recently shipped to the Metropolitan Railway Company, Washinton, D. C., and are to be equipped with storage batteries.

The Ball Engine Company is running its works at Erie, Pa., day and night, owing to an unprecedented number of orders. Mr. Frank R. Chinnock, 18 Cortlandt street, New York agent for the Ball Engine, has just returned from a visit to the South, where he succeeded in securing a large order During the past three weeks Mr. Chinnock has secured four orders aggregating 1,800 h. p.

The Electric Construction and Supply Company, 18 Cortlandt street, recently placed 26 Ward arc lamps in the works of the Harlem Wood and Lumber Company, 138th street. Among other recent orders for the "Ward Arc" may be mentioned: Fifty in the store of Charles Furst, Jersey City; 170 in the South Brooklyn factory, and 28 in the Elizabethport foundry of Henry R. Worthington.

N. P. Bowsher, South Bend, Ind., reports the following as a few of the recent sales of the Bowsher balancing ways: Ball Electric Light Company, New York City; J. H. & D. Lake Company, makers of friction pulleys, Hornellsville, N. Y.; F. B. Fargo & Company, Lake Mills, Wis.; Brown & Sharpe Manufacturing Company, Providence, R. I.; and the E. P. Allis Company, Milwaukee, Wis.

Taylor, Goodhue & Ames, 827 Monadnock Block, Chicago, Ill., has issued a very handsome little pamphlet describing the Burton electric heaters for which they are agents. The Burton heater has been in the field for a long time and its construction and the efficiency of its operation are now generally known, and it has been applied to street car heating in various parts of the country with great success.

Thomson & Bushnell, 120 Liberty street, New York City, are manufacturers of the Batchelder adjustable spring steam engine indicator. This indicator is correct for any steam pressure or vacuum without any extra attachment, in other words, it is complete in itself. While it is a highly sensitive instrument it is carefully made, and not likely to get out of order or be damaged by any ordinary usage. It has proved very popular, and in practice works with excellent results.

The Jewell Belting Company, Hartford, Conn., has decided, for the convenience of its many friends, to put up in neat packages of various sizes the cement which is used in its factory for the purpose of making endless belts and for general repair work. This cement can now be obtained in cans of 2, 5 and 10 lbs. each. This same company is also placing upon the market the belt dressing with which it has treated its belts for several years and which it can thoroughly recommend for use under all conditions.

The Shultz Belting Company, St. Louis, Mo., A. B. Lawrence, manager, 225 Pearl street, New York City, has issued a new catalogue which is got up in very attractive shape. While it contains all the necessary information with reference to the Shultz belting, a large portion of the pamphlet is given up to practical notes and tables, and other information of great use to engineers. The Shultz company is also getting up a handsome calendar for 1893, which will be sent, upon request, to all engineers and belt users.

R. H. Ingersoll & Bros., 64 Cortlandt street, New York City, among a great variety of other specialties, offer three neat little electric motors in addition to the dollar motor, which has already been described in THE ELECTRICAL WORLD. They make what is called the No. 3 Premier, wound for four and six volts, and intended for ventilating and running light machinery. The No. 2 Premier and No. 3 Premier are smaller motors of the same type They also supply batteries and telegraph and telephone outfits, etc.

The Wright Universal Electric Company, 25 Whitehall street, received the silver medal at the close of the American Institute Fair for its exhibition of primary batteries, as illustrated by their use in medical and surgical instruments, and also for bicycle, coach, table and reading lamps. During the National Carriage Builders' Association Annual Convention, held in the city of Buffalo October last, Dr. Robert Taylor, secretary of the Wright Universal Electric Company, disposed of fifteen hundred sets of coach lamps.

The New Jersey Lamp and Bronze Works, New Brunswick, N. J., is noted for its artistic work, and we are in receipt of some very handsome engravings of various fixtures manufactured by them. The design of the new cover of their catalogue is particularly attractive and displays excellent taste. This company does all its own designing and illustrating, as well as the engraving and printing, and has in its own works one of the most complete printing establishments in the country under the direction of Mr. George H. Blue. The designs above mentioned are by the company's own artist, Mr. C. McKnight Smith.

Test of Salamander Wire.—We have received from the Washburn & Moen Manufacturing Company, Worcester, Mass., a board upon which is mounted three samples of leading wires recently subjected to a severe test, together with a sample of the Salamander. A current of 150 ampères was sent through these samples for two minutes and the insulation was entirely destroyed on all the wires but the Salamander, which although tied into two knots did not show the effects of the heat in the slightest degree Tests made on this wire by the Massachusetts Electrical Engineering Company as well as abroad have shown, it is claimed, a water resistance of 5,000 megohms, after having been submerged in salt water from six to ten days.

The Railway Equipment Company, Chicago, reports a very large business in the Ahearn electric heaters. Orders for car heaters have been received from Amsterdam, N. Y.; Peoria, Ill.; Williamsport, Pa.; Kokomo, Ind.; Great Falls, Mont.; Camden, N.J.; Jackson, Mich.; Albany, N. Y.; Lynn, Mass.; Burlington, Ia.; Fitchburg, Mass.; Cairo, Ill.; Des Moines, Ia; Allentown Pa.; Rockford, Ill; Cleveland, O.; Detroit, Mich.; Brooklyn, N. Y.; Spokane Falls, Wash.; Alexandria, Va.; Kansas City, Mo.; Quincy, Mass.; Salt Lake City, Utah; Chicago; Natick, Mass.; Terre Haute, Ind.; Marquette, Mich.; Elwood, Pa; Escanaba, Mich.; Kankakee, Ill.; New Haven, Conn.; Galesburg, Ill.; Hammond, Ind, and large orders have also been received for the Ahearn electric stoves and other devices. The company states that in its opinion the Ahearn electric heater is the most reliable and satisfactory of any electric heater in the market.

Queen & Co., Philadelphia, are meeting with great success in exploiting their standard portable testing sets. One purchaser says: "The portable testing set referred to has been in use constantly since we received it, and we find it to be first-class in every respect. Have used it on all kinds of work, for both high and low measurements, and think it is about as complete an instrument of the kind as I have ever used." Another writes: "It has won our confidence to the extent that we accept it as a standard, not only as a portable instrument, but in a greater share of our laboratory work and electrical measurements. It is correct to within a small degree, easily manipulated, and results quickly obtainable, and can say that we do not know of one single point left to be desired in this instrument for an instrument of this nature." These instruments are made in a strictly first-class manner, and are adapted for use under the most exacting conditions, such as in a man hole or close to dynamo machinery. They are fully described in circular No. 285 issued by the makers.

W. R. Fleming & Co., representatives of the Harrisburg Foundry and Machine Works, and contractors for steam power plants for electric light and railway service, whose offices are in the Mail and Express building, New York City, have contracted for over 2,500 h. p. of engines during the past 30 days, among which are the following plants: 100-h. p. plant for electric railway service at New Britain, Conn., for which they are building two 500-h. p. tandem compound special railway engines of the "Ideal" self-oiling type; two simple "Ideal" engines for the Second avenue surface railroad in New York City, to be directly connected to multipolar dynamos similar to the four-unit plant now being installed in the Mail and Express building; two tandem compound "Ideals" of 225 h. p. each, to be shipped to Porto Rico, West Indies; also engines of the same type for the new Y. M. C. A. building at Hartford, Conn.; for a new hotel and for the Rochester Car Wheel Works. Two standard "Ideal" engines of 175 h. p. have just been ordered by the United States government at Portland, Ore.

Incorporation of Keasbey & Mattison.—The firm of Keasbey & Mattison, manufacturing chemists, at Ambler, Pa. (also the Magnesia Sectional Covering Company and the Magnabestos Company owned by the above named firm), has been transformed into a stock company with a capital of $2,000,000. The officers are Dr. Richard V. Mattison, president and general manager; Edward H. Hammer, vice president; George R. Wallace, secretary and treasurer. It is understood that the concern is of the nature of a close corporation, and that little or none of the stock will be sold. Mr. Henry G. Keasby, who has for some years past paid but little attention to the business, being absent in Europe on account of the ill health of himself and family, will now practically retire from active participation in the business, remaining at his European residence for several years in the immediate future. Dr. Mattison remains in active charge of the business, seconded by Mr. Hammer, who for many years has been identified as the New York representative of the house, and who has carried the main brunt of the various trademark suits instituted by the firm against infringers of the Bromo-Caffeine trademark. The new company will practically control the manufacture of magnesia in this country, and with their valuable trademarks and patents will possess a business of very considerable value Their technical (patented) magnesia product has been adopted by the government for protecting the steam surfaces of the new cruisers and other important works.

Business Notices.

Transformers rewound and repaired. Write for prices. The Hill Manufacturing Company, Salem, Va.

Oil Filter for sale cheap; send for prices to Purity Oil Filter Manufacturing Company, 901 Water street, Pittsburgh, Pa.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

[In Charge of W. A. Rosenbaum, 177 Times Bldg., N. Y.]

UNITED STATES PATENTS ISSUED DEC. 13, 1892.

487,703. Electric Meter; C. W. Ayton, New York, N. Y. Application filed Dec. 5, 1891. An electric meter consisting of the combination of a registering device controlled by a magnet, circuit closers normally in open circuit with said magnet and controlled by magnets in independent electric circuits, an ammeter in the main line of an electric distribution system, the needle of the said ammerer being nominally in open circuit with said second magnets, and an additional magnet being so arranged as to be periodically closed and attract said needle.

487,735. Conduit for Electric Railways; J. W. Hayden, Fort Wayne, Ind. Application filed Jan. 16, 1892. In a conduit for electric railways, the combination of one part of the conduit in which is placed the conductor with an outer part or plate extending from the surface of the roadbed down to a drain adapted to form one side of the slot for a trolley lever, a chair or brace attached to said outer plate and adapted to support and maintain it in position, a suitable support for the brace, placed below the drain, and a drain formed in the lower part of the conduit.

487,752. Contact Rail; F. E. Kinsman, Plainfield, N. J. Application filed Feb. 23, 1892. In a circuit closing apparatus for railway vehicles, a contact rail consisting of a metal bar set on the edge of the roadbed, in combination with a contact arm carried by the vehicle, and adapted to make contact with a corner of the contact bar.

487,755. Armature for Electro-Magnetic Machines; Robert Lundell, New York. Application filed Feb. 5, 1892. The combination of an armature core, the conductors surrounding same except on its inner periphery, a spider secured to the armature core, and conductors for connecting the armature conductors to form the working coil. (See illustration.)

487,796. System of Electrical Transmission of Power; Nikola Tesla, New York. Application filed May 15, 1888. The combination, with a multipolar alternating current machine having independent induced or current-generating circuits, of motors having independent energizing circuits, and a smaller number of poles than the generator. (See illustration.)

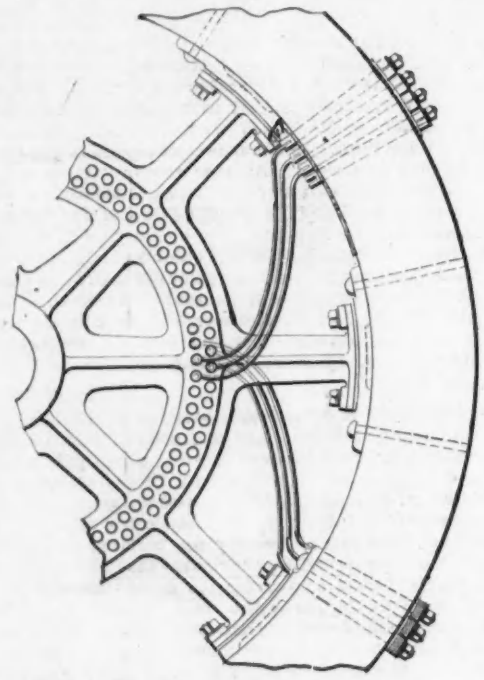
487,808. Trolley Catcher; J. Werling and J. F. Agnew, Minneapolis, Minn. Application filed Feb. 25, 1892. The combination with the car, of the trolley pole arranged thereon and provided with the trolley, a trolley rope, a short rope, longer than the rope, a retractive device connected with the lower end of the rope, and a spring latch arranged to support the same.

487,816. Atomatic Safety Device for Dynamo Electric Machines; F. B. Badt, Chicago, Ill. Application filed Feb. 13, 1892. The combination of a dynamo electric machine with the main circuit a responsive device therein, connections whereby such responsive device closes a local circuit when the main current has reached a predetermined maximum, field magnet circuit for the dynamo, a resistance normally out of such circuit, and a circuit changer to throw such resistance into circuit, said circuit changer being in the local circuit controlled by the responsive device.

487,834. Manufacture of Secondary Battery Electrode; W. W. Griscome, Haverford, Pa. Application filed Sept. 30, 1892. A lead plate or grid consisting of a group of conducting and supporting frames filled with thin integral sheets, strips or bars, which are separated from each other by narrow interstices of such a width as to be filled when the sheets, strips or bars are sufficiently converted into active material.

487,839. Galvanic Battery; H. T. Johnson, New York, N. Y. Application filed April 1, 1892. In a dry battery the combination of a positive electrode, forming a casing, a negative electrode within the positive electrode, and layers containing depolarizing and exciting agents arranged between said electrodes, a layer or lining of absorbent material interposed between the positive electrode and the layer, and a layer of absorbent material interposed between the layers.

487,846. Casing for Bases of Incandescent Lamps; G. R Lean, Boston; C. B. Burleigh, Chelsea, Mass. Application filed Nov. 27, 1891. A casing for the base of an incandescent lamp, made in two parts, one part being provided with means of attachment to the base and holding the other part in position around the base, the parts being shaped to receive a packing between them and also between one part and the lamp.



No. 487,755.—Armature for Electro-Magnetic Machines.

487,852. Multiple Switchboard Circuit; A. H. McCulloch, Boston, Mass. Application filed March 9, 1892. In an electric signalling system, a main circuit, an alternating current generator and a continuous current generator associated together at the same station of the said circuit, a circuit-closer, for connecting both to the said main circuit simultaneously, a polarized electromagnetic bell at a second station resposive to alternating currents only and adapted to give the signal upon the operation of said circuit closer.

487,853. Multiple Switchboard Busy Test Circuit and Apparatus; J. L. McQuarrie, Boston, Mass. Application filed April 7, 1892. In a multiple switchboard, the combination with each main line circuit of an earth branch normally connected therewith, an electric generator, a normally open local circuit therefrom and leading through the plug socket of said line, and adapted to be closed by the insertion of a plug connector in any of said sockets, and a relay included in such circuit and controlling the continuity of said earth branch.

487,854. Busy-Test Apparatus for Multiple Switch-Boards; James L. McQuarrie, Boston, Mass. Application filed April 7, 1892. An ordinary multiple switchboard busy-test apparatus comprising an electrical generator connected with the sleeve-uniting conductor of a double-connecting cord extending between the two plugs of a pair with an earth branch leading through high resistance relay magnets from the tip-uniting conductor of other loop-plugs, and apparatus controlled by the relay and adapted on the operation thereof to produce signals in a telephone with which it is inductively connected indicating the condition of the test line.

487,881. Automatic Switch; Nelson Newman, Springfield, O. Application filed Aug. 2, 1892. The combination with a suitable motor of a revolubie dial or disc carrying the pins or stops, and a switch provided with a rotating spindle and a tappet carried by the spindle and arranged in the path of the stops or pins on the dial.

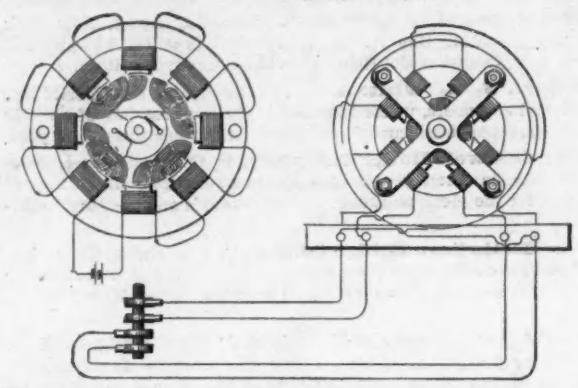
487,890. Manufacture of Incandescent Electric Lamps; Casimir Pauthonier, Boston, Mass. Application filed April 30, 1892. The mode of manufacturing incandescent lamps, which consists in sealing the leading-in wires to the bulb, then introducing the filament through an opening in the bulb and fixing it upon the electrodes, then building up the filament to a uniform resistance, and finally exhausting and sealing the bulb.

487,904. Signal Device for Railways; Zdenko Krulis, Chicago, Ill. Application filed March 28, 1892. The combination with two meeting railroad rails of a vertically sliding rod lying in a chamber formed in the ends of the rails and projecting slightly above the tread of the rails, a spring pressing the rod upward and holding it normally in its raised position, and two terminals of an electric circuit, one of these terminals being operated by the spring and thereby pressed against the other when the spring is pressed downward by the downward movement of the rod.

487,936. Automatic Keyboard-Operator; Henry S. Prentiss, Elizabeth, N. J. Application filed June 19, 1891. In a keyboard operator for type-writing machines, an electromagnet for each key, a series of circuit closers, a series of switches operated by the passage of a perforated strip between the circuit closers, and a main circuit closer for closing the circuit through the contacts set by the switches.

487,981. Printing-Telegraph; Charles L. Buckingham, New York. Application filed Nov. 10, 1888. The combination of a type wheel, a series of independent impelling devices for actuating them, and a driver and follower positively joining the type wheel with each impelling device, and forming a positive operative connection between them both during the single and combined action of the impelling devices.

487,982. Printing-Telegraph; Charles L. Buckingham New York. Application filed April 24, 1890. In a telegraph system, the combination of an unbroken main line, a main line relay at the receiving station, automatic transmitter by which each letter or character is transmitted by a series of pulses succeeding one another, and a printing instrument having a series of type adjusters whose limits of action collectively are commensurate with the entire range of type wheel movement.



No. 487,796.—System of Electrical Transmission of Power.

487,983. Printing-Telegraph; Charles L. Buckingham, New York. Application filed April 29, 1890. In a printing-telegraph, the combination of a main line, a relay, a sunflower, a series of sunflower branches containing selecting relays, a series of actuating magnets, and a series of circuits formed through the tongues of the electric relays, by which the actuating magnets may be brought into action one at a time to actuate printing levers.

487,984. Synchronous Multiple Telegraph; Charles L. Buckingham, New York. Application filed April 30, 1890. In a synchronous telegraph, a synchronizing arrangement consisting of a battery in a branch at one station, a duplex relay at the other station, a local circuit and a unison-motor controlled thereby.

487,985. Printing-Telegraph; Charles L. Buckingham, New York. Application filed Dec. 11, 1889. In a printing telegraph, the combination of a type-wheel and a press mechanism, the two being independent one of the other, an automatic transmitter for periodically operating the press mechanism to give impression blows after each adjustment, and a unison mechanism connecting the impression devices and transmitter.

487,986. Printing-Telegraph; Charles L. Buckingham New York. Application filed April 25, 1890. In a multiple synchronous telegraph system for operating a printing-telegraph, the combination of a duplex relay at the transmitting station for effecting synchronism, a local circuit and a synchronizing motor having a field magnet as shown, and an armature body formed of a segment of an iron ring.

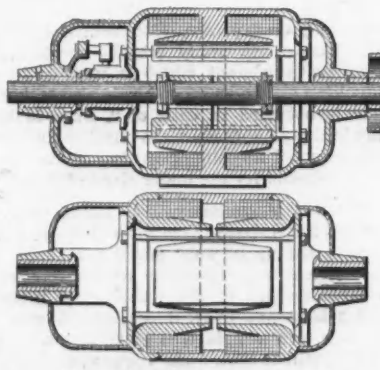
488,002. Lightning Arrester; William R. Garton, Keokuk, Ia. Application filed July 11, 1892. In a lightning arrester for electric lines, the combination of serrated plates, an air-tight chamber, a solenoid, an armature provided with a guide-rod, a carbon rod carried by the armature and electrical connections.

488,012. Electric Gas-Lighter; Lucien M. Kilburn, Council Bluffs, Ia., and Scott Van Etten, Omaha, Neb. Application filed March 21, 1892. An automatic electric gas lighter, comprising a cut-off valve, lighting and extinguishing electromagnets, their polar extensions having their inner faces curved on an arc eccentric to the axis of the valve, armatures independently suspended from axial extensions on the valve and having their contact faces curved on an arc concentric to the valve axle.

488,013. Electric Belt; Ole Kjorstad, Eau Claire, Wis. Application filed May 11, 1892. A body belt with continuous pocket, a fixed end and central contact electrodes or plate having connecting hooks projecting into the pocket, separate battery sections having at end of battery connecting loops adapted to removably engage connecting hooks at end, and central contact electrodes, an intermediate connecting wire to removably connect its ends with the central electrodes, and provide for completon of the circuit.

488,016. Armature for Electric Machines; Benjamin G. Lamme, Pittsburgh, Pa. Application filed Feb. 8, 1892. The combination, with a drum-armature core, having radiating teeth, of coils of insulated wire placed within the spaces between the teeth, each coil spanning several teeth, the coils being separately wound and separately insulated.

488,022. Electric-Railway Trolley; David Mason, New York. Application filed Nov. 11, 1889. The combination, with an electric railway car and an overhead conductor, of a contact device making underneath contact with the conductor, a pole carrying the contact device, and a flexible resilient support for the pole adapted to turn around a vertical axis.



No. 488,041.—Electric Motor.

488,023. Electric-Railway Trolley; David Mason, New York. Application filed March 3, 1890. The combination, with an electric-railway car and an overhead conductor, of a contact device making an underneath contact with the conductor, a pole carrying the contact device and hinged on the car, and a spring coiled on the axis of the pole and exerting an upward pressure thereon.

488,027. Electric Coupling; John H. Purcell, Washington, D. C. Application filed June 18, 1892. In combination, an underground conductor, of a spliced cable provided with a suitable housing consisting of a cylindrical surface being recessed for a short distance from the ends, and provided with washers which are flush with the ends of the tubing, rubber washers and caps received directly on to the ends of the tubing.

488,033. Spring-Jack Switch; Charles E. Scribner and Ernest P. Warner, Chicago, Ill. Application filed July 3, 1888. The combination with the springs of a circuit changer adjusted to press normally each against a different contact piece placed between the springs of a metallic tube or test piece placed in front of the free ends of the springs, the tube being permanently connected with one of the springs.

488,034. Means for Preventing Induction in Cables of Multiple Switchboards; Charles E. Scribner, Chicago, Ill. Application filed March 5, 1892. The combination with a normally closed conducting loop having one side, including contact pieces, adapted to open the loop when separated, of a third wire connected at one extremity to that side of the loop which is adapted to be opened, and to a point thereof whereby it is separated from the permanently continuous branch of the loop when the loop is open, the third wire extending parallel and near to the permanently closed side of the loop.

488,035. Multiple Switchboard System for Telephone Exchanges; Charles E. Scribner, Chicago, Ill. Application filed March 17, 1892. The combination, with a telephone line extending from a sub-station to a central station, of an individual annunciator at the central station provided with two coils adapted to act differentially or oppositely upon an indicator, one of the coils being included in the line circuit and the other included in a branch therefrom to earth, and means for connecting a grounded source of electricity to that side of the line to which the grounded coil is attached.

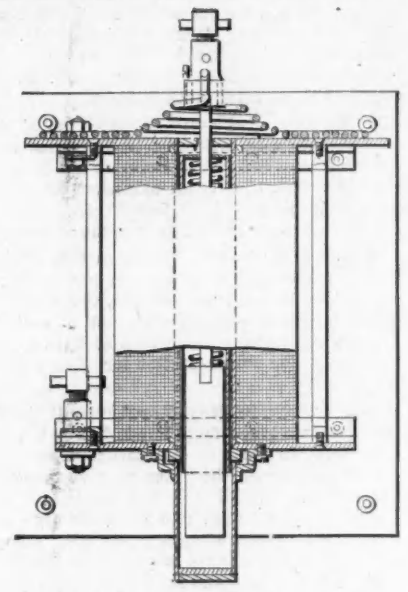
488,036. Multiple-Switchboard System for Telephone Exchanges; Charles E. Scribner, Chicago, Ill. Application filed April 16, 1892. The combination, with an individual annunciator, of an electro-magnetic switch adapted to close the circuit when energized, a shunt or short circuit about the annunciator normally open at two points, adapted to be closed at one point by the electromagnetic switch, and means for closing the short circuit at another point when connection is made with the line.

488,037. Telephone Switchboard Apparatus; Charlee E. Scribner, Chicago, Ill. Application filed April 16, 1892. The combination with a telephone line of spring-jacks connected therewith and an individual annunciator in circuit therein, an electro-magnetic device adapted when energized to prevent that actuation of the indicator of the annunciator, a local circuit including the said electromagnetic device, and a source of electricity normally open at two points, contact points upon the spring jacks forming the terminals of one of the breaks in the local circuit, and contact points thereon adapted to be closed together when the device is energized, the contact points forming the terminals of the remaining break in the local circuit.

488,038. Multiple-Switchboard System for Telephone Exchange; Charles E. Scribner, Chicago, Ill. Application filed April 18, 1892. The combination, with a telephone line circuit, of spring-jack switches having contact switches normally insulated therefrom and an electromagnetic device included in the line circuit or in a branch therefrom, adapted when energized to connect the contacts of spring-jack switches to the line circuit and means for energizing the electromagnetic device.

488,041. Electric Motor; Imle E. Story, Boulder, Colo. Application filed Feb. 4, 1892. The combination, with an armature, of a multipolar field-magnet consisting of a cylinder surrounding the armature and having pole pieces projecting from its middle portion inward and other pole pieces projecting from its middle portion outward, the different pole pieces alternating with each other around the armature, and exciting coils confined between the cylinder and pole pieces. (See illustration.)

488,046. Insulator; Charles Wirt, Chicago, Ill. Application filed Jan. 4, 1892. In a strain insulator, the combination of two pieces, each provided with an eye or hook at one end and one with a cup, the other with a body adapted to be received in the cup, and insulating material interposed between the body and cup and entirely covering all the surface of both parts.



No. 488,121.—Automatic Regulator.

488,053. Test-Circuit for Multiple Switchboards; Oro A. Bell, Brooklyn, N. Y. Application filed March 12, 1891. In a listening key for telephone exchange systems, the combination of normally open contacts adapted when closed to connect the operator's telephone to a subscriber's line, means for closing the contacts, a testing and ground connection therefrom, and contacts in the ground connection closed by the act of connecting the operator's telephone to line.

488,064. Magnetic Separator; Harvey S. Chase, Boston, Mass. Application filed Jan. 29, 1892. In combination with the operative parts of a magnetic separating machine, a magnet composed of a flat core, a series of coils wound alternately in opposite directions on the core and a series of pole pieces placed crosswise of the core between the coils.

488,107. Time-Meter for Electric Lighting Systems; Judson O. Ball, Mt. Pleasant, Ia. Application filed Feb. 20, 1892. In a time meter, the combination, with an ordinary clock mechanism, of a movable registering device and cut-out connected with the registering device and adapted to throw it into engagement and out of engagement with the clock movement when the electric circuit is closed or opened, respectively.

488,121. Automatic Regulator; Edward J. Houghton and William White, London, England. Application filed March 26, 1892. An apparatus for automatically regulating electric currents, consisting of a solenoid coil, a core movable therein, a spiral resisting wire forming part of an electric circuit, and having a greater or less number of its convolutions short circuited, and a rod connecting the core with the innermost convolution of the spiral resisting wire. (See illustration.)

488,123. Electrical Safety Cut-Out; Henry Sheehy Keating, London, England. An electrical safety cut-out consisting of a U-tube hermetically closed at its one end, through which passes a conducting wire into the space in the tube charged with nitrogen or equivalent gas, a charge of mercury in the tube such that the lower end of the wire dips into it, and another conducting wire which dips into the mercury in the other limb of the tube.

488,138. Electric Signal Circuit; John V. Young, Boston, Mass. Application filed June 29, 1892. The combination of batteries located at or near each end of the signal section, signal controlling or operating circuits connected to the batteries and looping through contact points of relays included in a signal circuit, also connected to the batteries and extending along the signal section, and signal controllers so constructed that when shifted to break the signal circuit they will complete the signal operating circuit.

488,139. Incandescent Lamp; Eugene W. Applegate, Omaha, Neb. Application filed April 7, 1892. A lamp comprising a bulb, the lava cap or plug having a cylindrical portion and upper widened end supported by the bulb, the leading-in wires of aluminium, extended through the cap or plug, the carbon filament connected at its ends to the leading-in wires, the vertical exhaust tube leading centrally through the cylindrical portion of the cap, the socket removably secured to the cap and having circuit wires extending therein, and connections between the latter and the leading-in wires.

488,141. Process of Insulating Electric Conductors; Charles Cuttriss, New York. Application filed Jan. 20, 1892. A method of preparing cotton sliver for application to electrical conductors, which consists in drawing the sliver in its natural state through a boiling non-viscous insulating fluid, such as oil, and then matting or felting it and expressing the surplus oil taken up by it.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.